Inverter to
DC-DC Converter for Audio Isolation Amplifier

The described inverter provides two output voltages galvanically separated from each other as well as from the power supply. I designed the inverter for an isolation amplifier from PE 7/2001, but nothing prevents it from being used in other applications.

Specifications

Input voltage Ui:	*Input voltage:*	12 V (5 to 15 V)
Output voltage:	*Output voltage:*	about 0.9 Ui.
Maximum performance:	*Max output power:*	> 1 W.
Efficiency:	*Efficiency:*	about 75%.
Working Frequency:	*Switching Frequency:*	about 400 kHz.
No-load sampling:	*Supply Current:*	10 mA.
(Data measured at 12 V / measured at Ui = 12 V)		

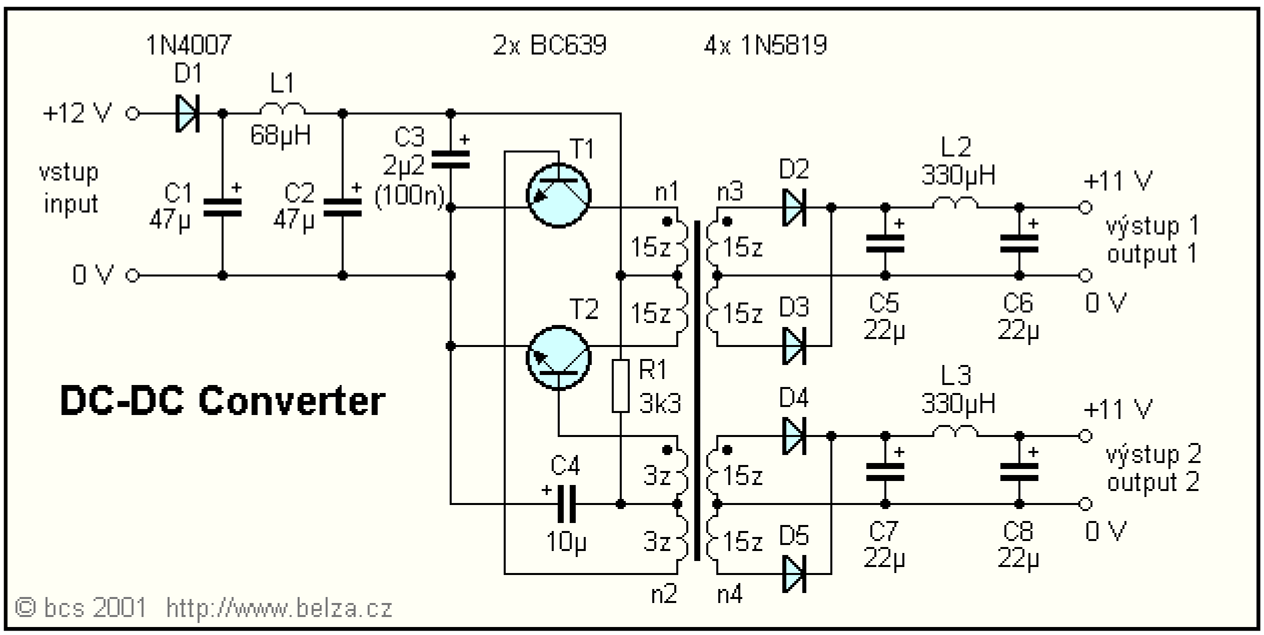

Fig. 1. Converter for isolation amplifier
Figure 1. DC-DC Converter for isolation amplifier

Description involvement

The base of the inverter is a self-absorbing double-acting transducer with transistors T1 and T2 (**Figure 1**). This connection was chosen primarily because of its simplicity, although it does not achieve peak performance. Because of the relatively small power output it is not too much of a fault. The feedback winding n2 is used to blunt the drive. Since the voltage from the feedback winding is directed at the transistors transitions, a negative voltage of about 1 V appears in the center of the winding. Polarity C4 is therefore in the diagram correctly.

The T1 and T2 transistors alternately connect the ends of winding n1 to the ground. After the transistor is switched on, the current of the winding, connected in the collector of the respective transistor, will increase and at the same time the current excited in the winding n2 will increase. The transistors remain open for as long as they just open their current to the base excited in n2. On average, this current is the same as that passed through resistor R1. If the voltage starts to increase on the transistor, the voltage at the winding n1 decreases and the current excited in n2 decreases. The transistor closes and the second transistor opens. On the winding in the collector, the voltage increase is practically the same as the supply voltage. Since the secondary windings have the same number of threads, almost the same voltage will appear on them. This voltage is controlled by Schottky diodes D2 and D3, respectively. D4 and D5. There is also an output filter behind the rectifier, which reduces the output voltage interference by the inverter frequency. A similar filter is also connected to the input side of the inverter. If you do not reverse the polarity of the supply voltage, you can replace the diode D1 with the jumper. The efficiency of the drive increases.

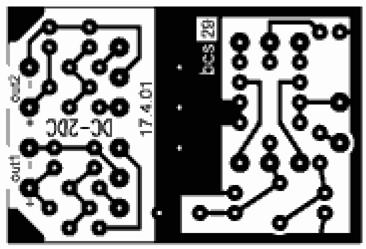

Fig. 2. Circuit board for inverter. Click to get the image in 600 dpi resolution
. 2. DC-DC PCB layout. Click to get 600 dpi resolution image

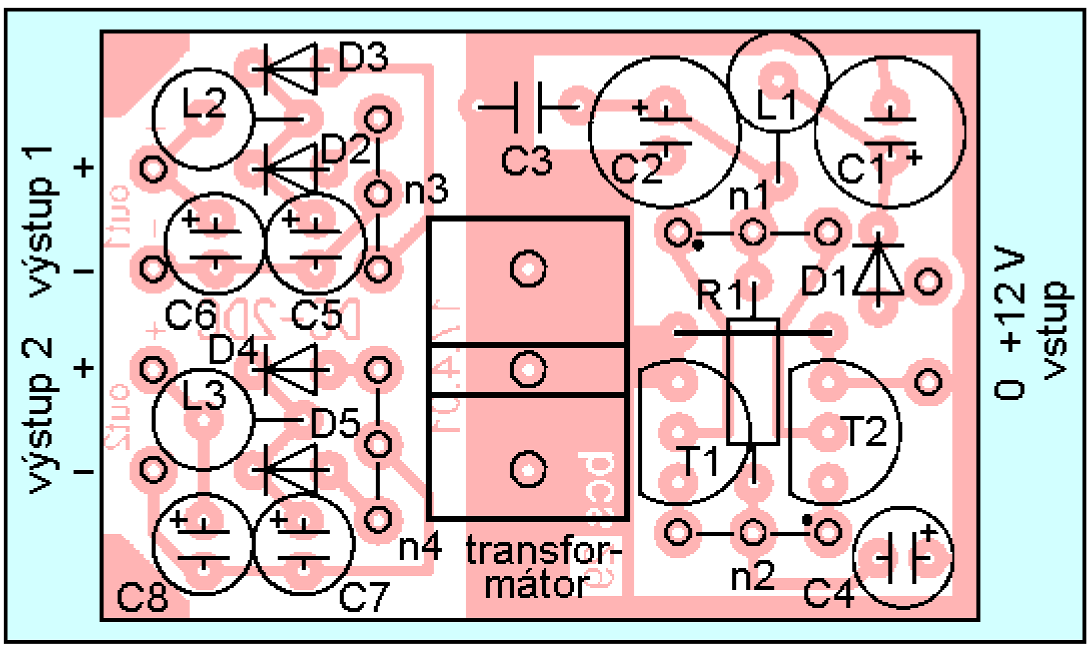

Fig. 3. Layout of components on the board
Figure 3. Locations of components on the board

Construction and recovery

The used components are common, the chokes are TL type ... The transformer was wound on a 14 mm diameter outlet cup of H12, given Al = 160. The winding sense n1 and n2 must be observed. The transformer is fastened with a plastic screw in the U-shaped clamp. The screw must be tightened only slightly, otherwise the core bursts. Due to the labor productivity of the coil I did not experience the transformer too much. However, with more threads (greater inductance), it would seem that the drive could have greater efficiency and less quiescent current on the same core. Also, kernels with large Al will not be suitable for this type of inverter. The inverter coil was wound onto the scab for the used cup core, and each winding was separated by several threads of adhesive tape (I did not have a transformer paper). It was manually wrapped, the bone was attached to a

wooden spindle. The number of threads and wire diameters are listed in the parts list. The exact number of threads and the diameter of the wire is not so important, I wound up the coil with what was at hand. The double windings have been wound with two wires at the same time so that both windings have the same number of turns. The end of the first and the beginning of the second I have joined and thus created the center of the winding. After the recovery, the inverter board was inserted into the AH-100 box. The inverter should "tighten" the 12 V / 1.2 W lamp. If it does not deliver the required power, reduce the resistance of the resistor R1. After the recovery, the inverter board was inserted into the AH-100 box. The inverter should "tighten" the 12 V / 1.2 W lamp. If it does not deliver the required power, reduce the resistance of the resistor R1. After the recovery, the inverter board was inserted into the AH-100 box. The inverter should "tighten" the 12 V / 1.2 W lamp. If it does not deliver the required power, reduce the resistance of the resistor R1.

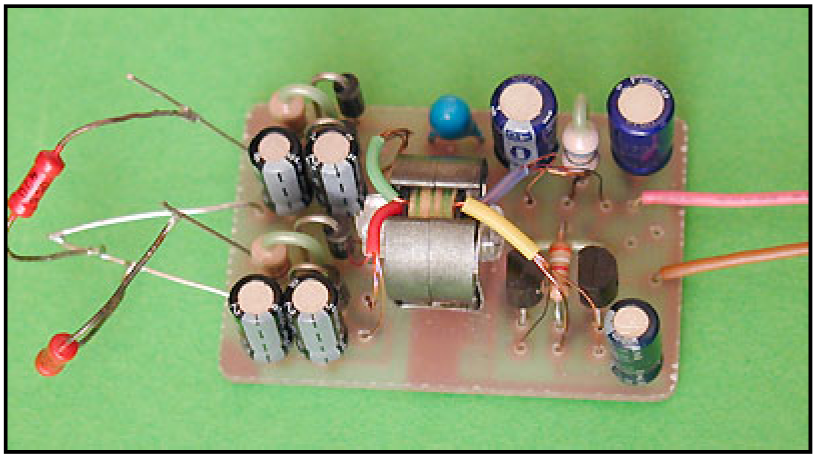

Fig. 4. In-phase inverter
Figure 4. DC-DC Converter in building period

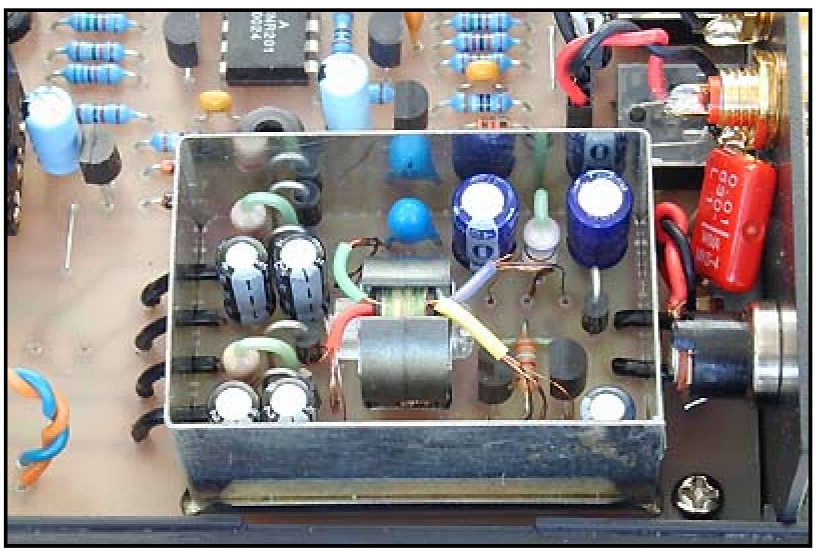

Fig. 4. Converter in opto-isolation amplifier (without cover)
Figure 4. DC-DC converter in Audio Isolation Amplifier (without cover)

Parts list

R1	3.3 kOhm
C1, C2	47 µF / 16 V
C3	2.2 µF (microF), tantalum. or 100 nF, ceramics.
C4	10 µF (microF) / 16 V
C5, C6, C7, C8	22 µF (microF) / 16 V

D1	1N4001 (1N5819)
D2, D3, D4, D5	1N5819
T1, T2	BC639
L1	68 µH (microH), TL.68µH
L2, L3	330 µH (microH), TL.68µH
Tr	Transformer / Switching transformer n1 15 + 15 z (Diameter 0.18 mm CuL / AWG 33) n2 3 + 3 z (Diameter 0.18 mm CuL / AWG 33) n3 15 + 15 z 33) n4 15 + 15 z (diameter 0.18 mm CuL / AWG 33) core diameter 14 mm, Al = 160, mass H12
	box AH100
	printed circuit board bcs29

Jaroslav Belza

The connection was published in Practical Electronics 8/2001 at page 23

12. 8. 2001
5. 3. 2002 upd.

Antenna unit 1

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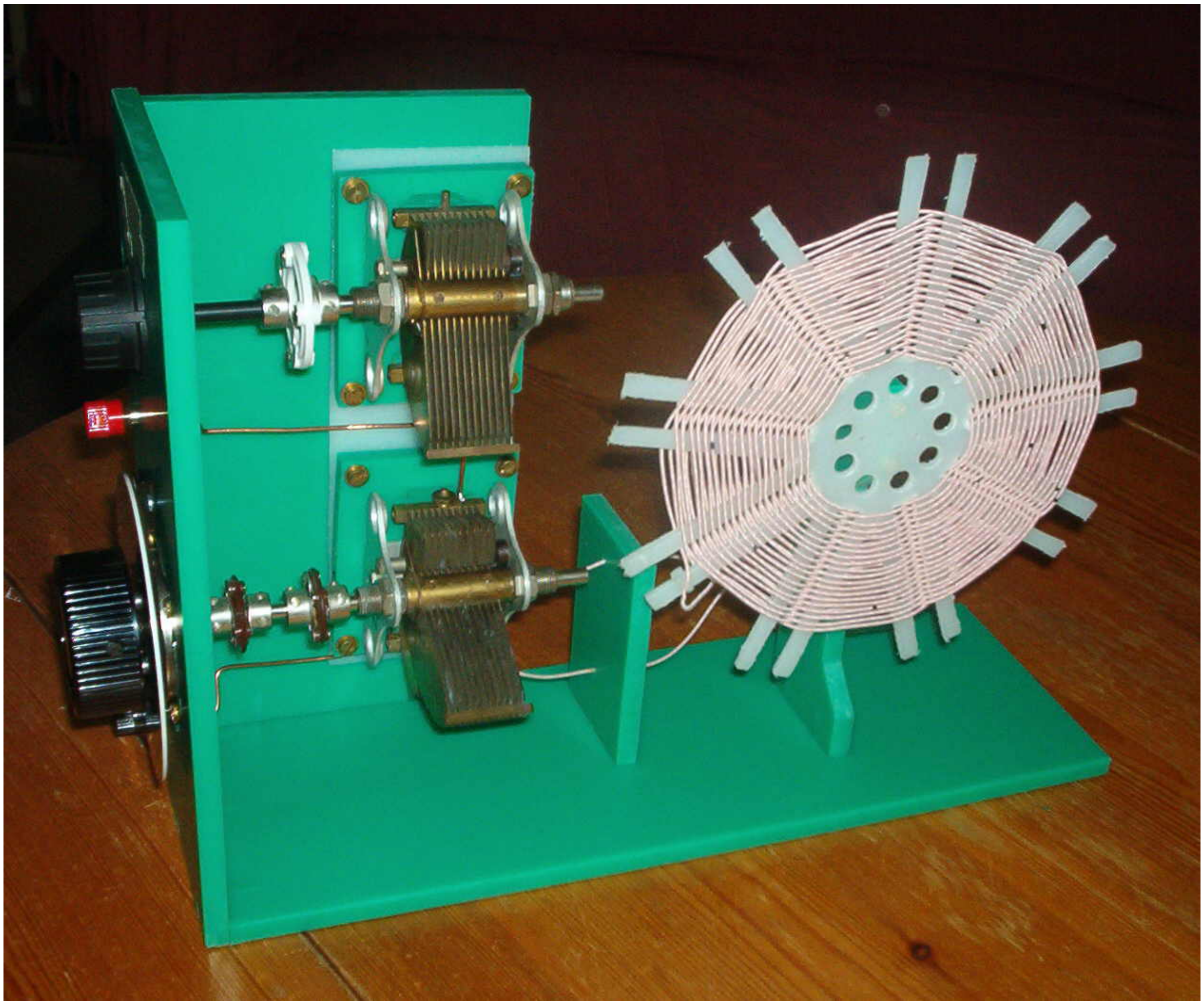
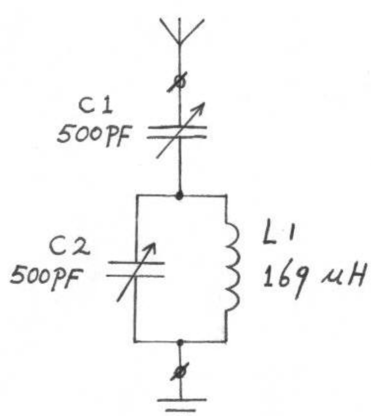
Here a description of a antenna tuner unit.
It is used in combination with a detector unit (e.g. detector unit 1) , so a double tuned receiver is formed.





Schematic of the antenna unit.

The antenna unit has a tuned circuit L1, C2.
If we only look at L1 and C2, then the tuning range is 550 - 2184 kHz.
But if we also connect the antenna and earth, the frequency of the circuit will decrease, so we can also receive

the lowest mediumwave frequency of 530 kHz.
Variable capacitor C1 and the antenna and earth are also a part of the tuned circuit, but the antenna and earth also give reduction of circuit Q.

The circuit L1,C2 has a high impedance (e.g. 1 M.Ohm).
But the antenna has a low impedance (e.g. 10 Ohm), tuning capacitor C1 forms a impedance match between this high and low impedance.

With a certain value of C1, there wil be maximum power transfer from antenna to the circuit L1,C2.
Then there is maximum voltage across the coil L1, and maximum sensitivity of the receiver.
At low frequencies we must for instance adjust C1 to 100 pF, and at high frequencies to 20 pF, but these values are depending on the (lenght of) antenna we connect to it.
For the circuit Q however, the lower the value of C1, the higher the Q.
More information about this, you wil find here.

Coil L1 is wound with litzwire 660x 0.04mm (660/46 AWG), on a polypropylene former.
This coil is described here as coil L12, only the outermost winding is removed to reduce inductance a little bit.
This reduced the total wirelenght from 15 to 14.5 meters.

The frame of this antenna unit is made of 8mm polyethene sheet.
Tuning capacitor C2 is driven via a 1:5 vernier drive, so we can tune it very accurate.
Tuning capacitor C1 has no vernier drive.

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Detector unit 1

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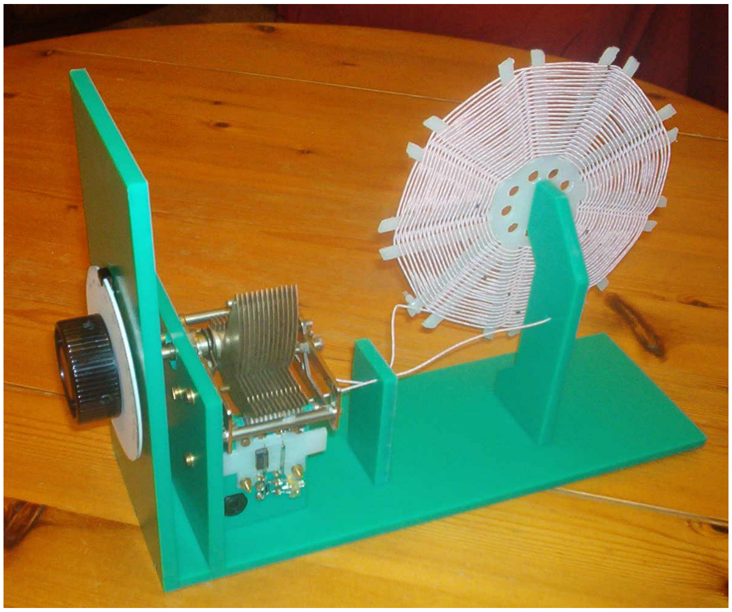
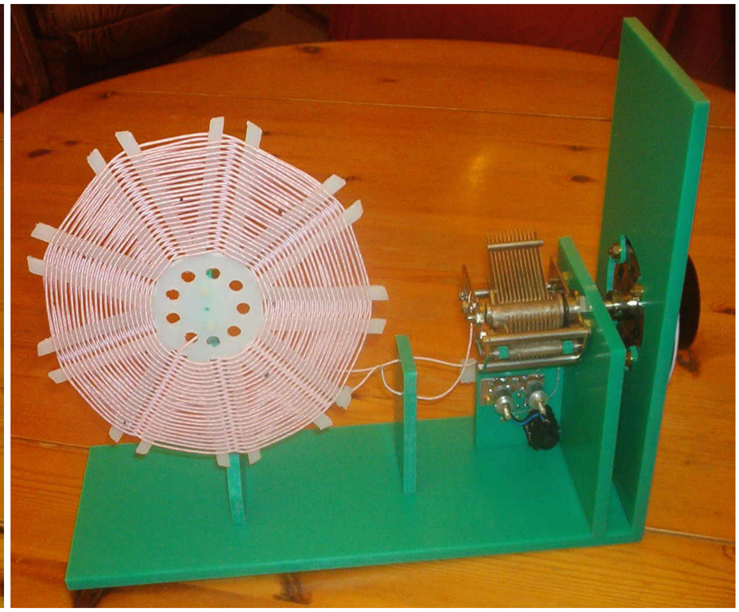
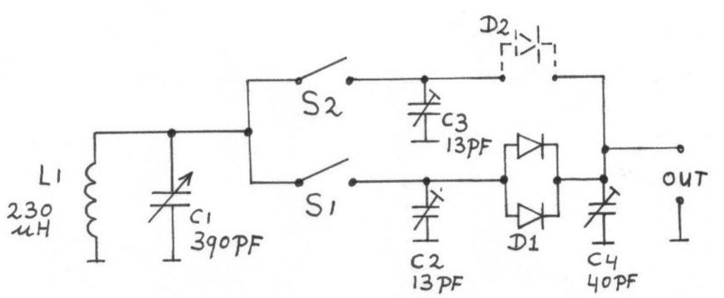
Here the description of a detector unit, this can be used in combination with an antenna unit, so that a two-circuit receiver is created.
An audio transformer with a high input impedance such as my transformer unit1 is connected to the output .



Detector unit 1



The two trimmer capacitors are located under the tuning capacitor.



Schematic of the detector unit.

Coil L1 is a coil of litz wire 660x0.04 mm (660/46 AWG) and is wound onto a polypropylene coil holder.
This coil is described here as coil L13.

The tuning capacitor has silver plated plates and insulators of polyethylene, and is described here under the name C2b.

The switches S1 and S2 are reed switches which can be switched by placing a magnet on them, these reed switches with glass housing give little dielectric losses.
When opened, the switch contacts have a capacity of about 0.2 pF.

With trimmer capacitors C2 and C3 the frequency range of the detector unit can be set.

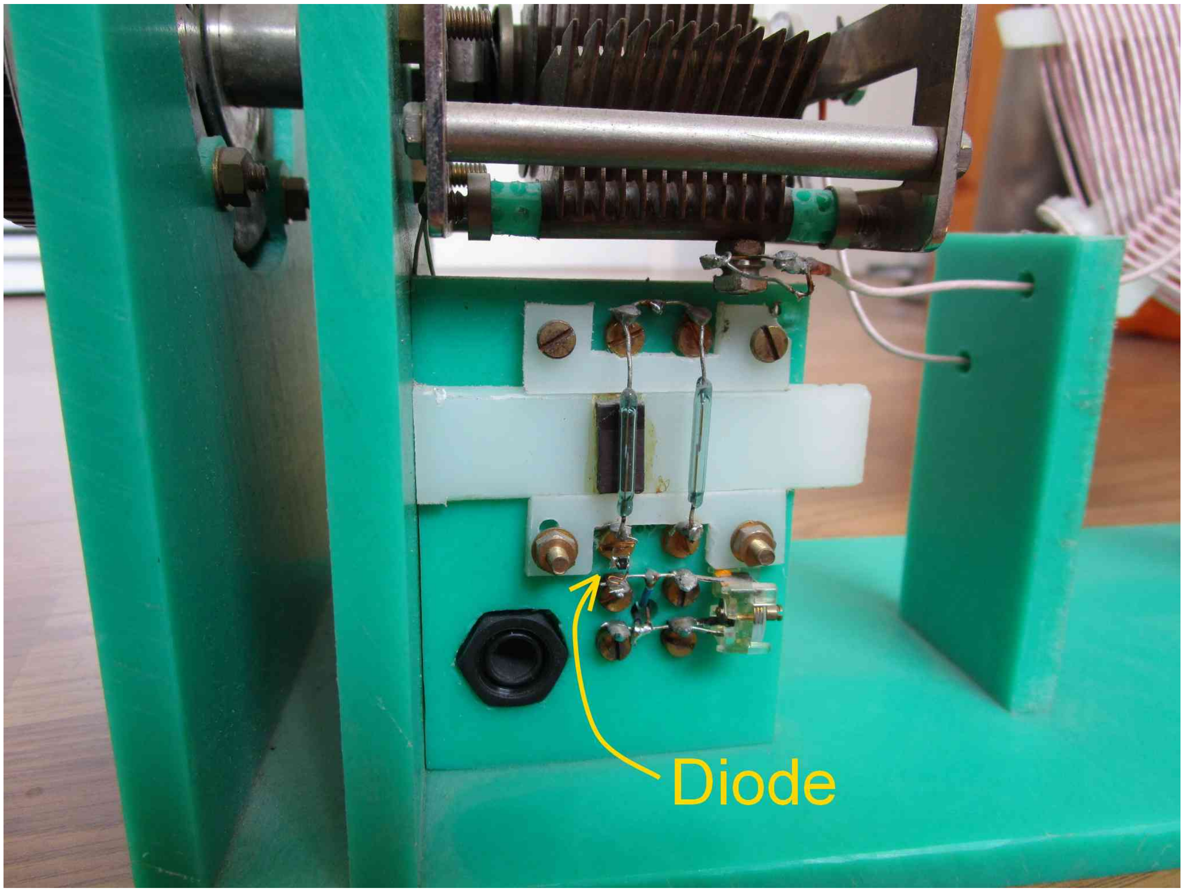
Diode D1 is a double SMD schottky diode of the type HSMS282K, the two diodes in the housing are connected in parallel. This type of diode also has a shield between the two diodes, the connection pins of the shield are not connected. After soldering all solder flux is removed from the diode, as this can have a negative influence on the Q factor of the circuit.
More information about diodes can be found here .

A second diode can also be connected (D2), so that it is possible to switch between D1 and D2.

C4 is for removing the high-frequency signal behind the diode, the value is variable so that I can experiment with it.

The output of this detector unit must be loaded high Ohmig, preferably with more than 1 M.Ohm.

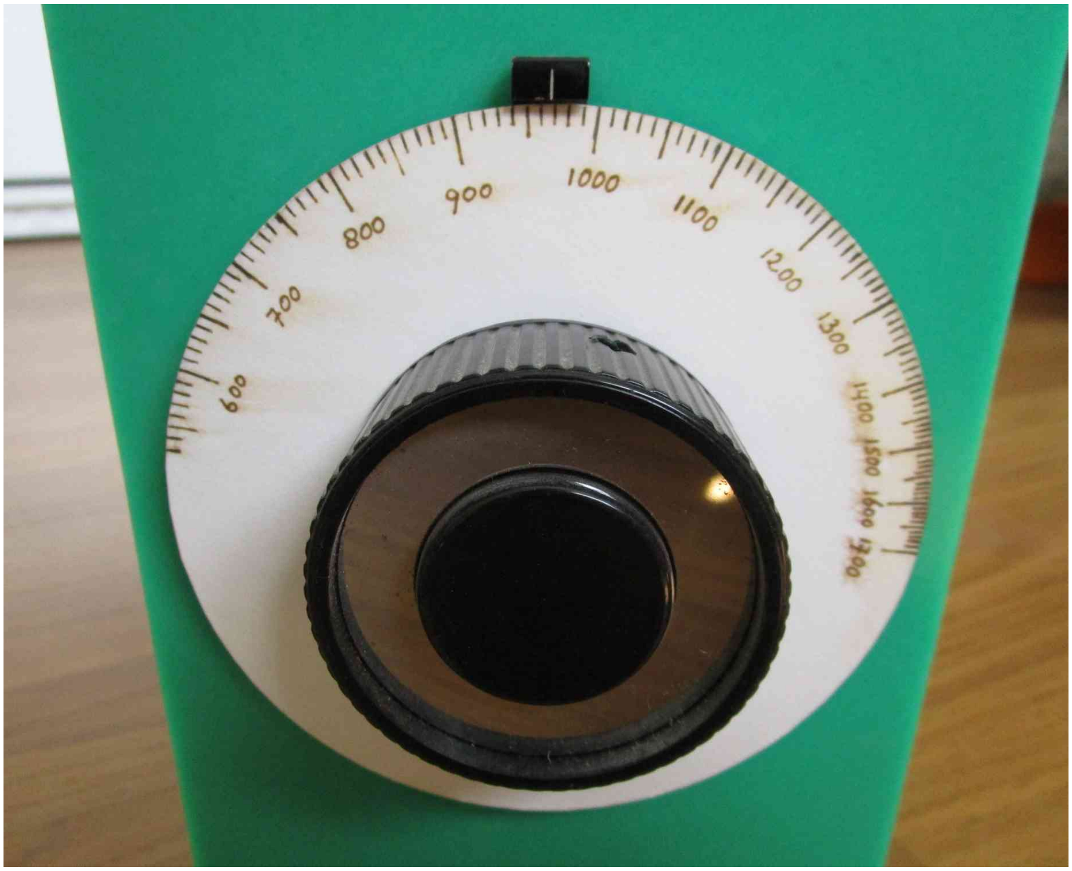
The detector unit is made of polyethylene plate, this gives little dielectric losses, more information can be found here and here . Only copper screws were used, no iron because of the lower losses.



Detail of the reed switches, those are the two glass tubes.
The magnet can be moved from left to right, so that one or the other reed switch is switched.
The diode D1 is located at the bottom of the left reed switch, but is almost too small to see.

Tuning scale of the detector unit. The frequency can be read directly on the scale.

There is a 1: 5 delay between the tuning knob and the tuning capacitor.
The tuning scale is connected to the tuning capacitor and therefore runs 5 times as slow as the button.



From the detector unit I measured the Q factor, once without the diode connected, and once with the diode (2 parallel) and a load resistor of 1.5 M.Ohm.
Also the frequency shift that the diodes give is measured.
(This measurement was done with 1.12 Volt top-top over the LC circuit at the resonance frequency.)

	Q at 600 kHz	Q at 900 kHz	Q at 1200 kHz	Q at 1500 kHz
Detector unit unloaded	**1276**	**1204**	**1111**	**912**
Detector unit loaded with 2 diodes HSMS282K parallel and 1.5 M.Ohm.	**644** -1.0 kHz	**529** -3.3 kHz	**405** -8.1 kHz	**326** -15.0 kHz

With the formula Z = 2.pi.fL Q we can calculate the impedance of the unloaded circuit (the inductance of the coil is 230 uH):

Z = 1.1 M.Ohm at 600 kHz
Z = 1.57 M.Ohm at 900 kHz
Z = 1.93 M.Ohm at 1200 kHz
Z = 1.97 M.Ohm at 1500 kHz

The frequency range of the unit was first 530.65 to 2050 kHz, which was measured with the diode connected.
I wanted to lower the lowest frequency, because it is too close to the lowest medium wave frequency of 531 kHz.
If I used a different diode with less capacity in the future, the 531 kHz would not even be achieved.
I also wanted to lower the highest possible frequency to about 1700 kHz, so that the stations spread over the frequency scale, so the stations are not so close together.
Here in Europe the highest medium wave frequency is 1620 kHz, but up to 1700 kHz there are also some pirate stations active, which are also interesting to hear.

To limit the frequency range, I have put a trimmer capacitor parallel to the tuning capacitor.
The maximum capacity of this trimmer capacitor is 13.8 pF.
With the trimmer at maximum capacity I measured the Q of the unloaded circuit.
600 kHz Q = 1224
900 kHz Q = 1210

1200 kHz Q = 1090
1500 kHz Q = 898

We see that the trimmer capacitor has little influence on the Q factor.

Two trimmer capacitors are used (C2 and C3), these are placed behind the reed switches, so each diode has its own trimmer.
Now it is also possible to eliminate differences in capacitance between the different diodes, so that the switching from one diode to another does not cause a frequency shift.

By means of the trimmer capacitors I have adjusted the frequency range of the detector unit to 522 to 1710 kHz.

With the detector unit I can receive the following stations, in this case no external antenna is connected, I only use the coil of the detector unit as a small loop antenna.

Freq.	Station	Country	Location	KW	KM	Reception during the day
540	Radio 2	BEL	Wavre-Overijse	150	158	*
594	Hessischer Rundfunk Chronos	D	Rodgau Frankfurt	250	359	
621	RTBF 1	BEL	Wavre	300	158	*
648	BBC Worldservice	G	Orfordness	500	445	*
675	Arrow	HOL	Lopik	120	17	*
747	747AM	HOL	Flevoland	400	41	*
756	Deutschlandfunk	D	Ravensburg	100	585	
927	Radio 1	BEL	Wolvertem	150	137	
972	NDR Info	D	Hamburg	100	379	
1008	Radio 10 Gold	HOL	Flevoland	400	41	*
1053	Talk Sport	G	Droiwich	500	479	
1062	DR P3	DNK	Kalundborg	250	559	
1089	Talk Sport	G	Brookmans Park	400	354	
1134	Hrvatski Radio 1	HRV	Zadar	600	1175	
1179	Radio Sweden international	S	Solvesborg	600	763	
1215	Virgin Radio	G	Moorside Edge	200	487	
1296	BBC World Service (DRM signal)	G	Orfordness	70	229	
1314	NRK1 / NRK 2	NOR	Kvitsoy	1200	767	
1377	France Info / RFI	F	Lille	300	227	
1422	Deutschlandfunk	D	Heusweiler	600	341	
1440	RTL	LUX	Marnach	300/1200	248	
1458	Sunrise Radio	G	Brookmans Park	125	422	
1467	Trans World Radio / Radio Vatican	F	Romoules	1000	934	
1539	PROPERTY	D	Mainflingen	120/700	366	

These stations were received late at night.
A * in the last column indicates that the station can also be received during the day.
The detector unit was placed on a wooden table which gives a small decrease of the Q factor.

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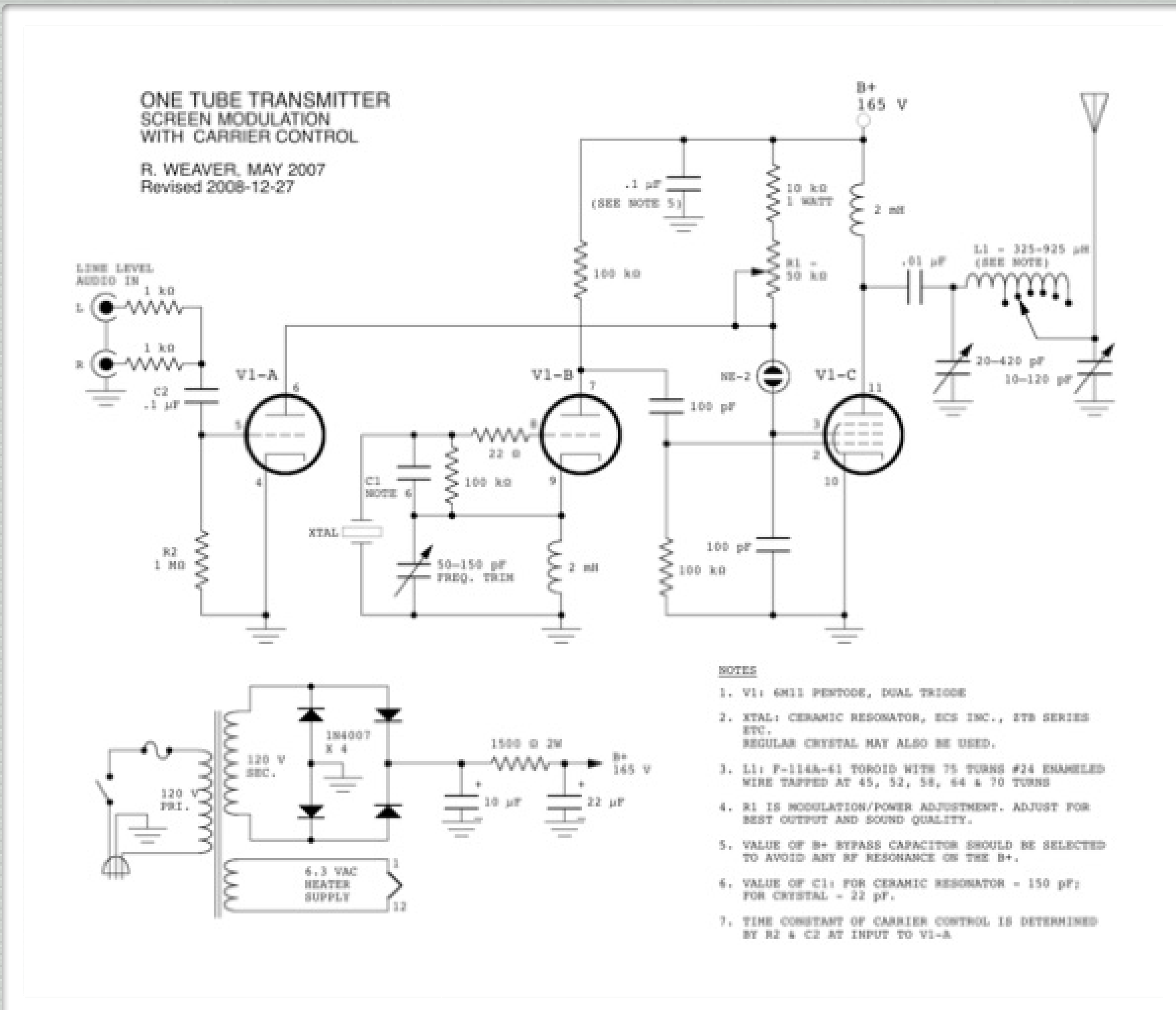
1-Tube AM Broadcast Transmitter

This little transmitter came about as a result of my interest in vintage radio receivers, and the lack of anything worth listening to on the AM broadcast band (540 - 1700 kHz). With a transmitter, I could broadcast my own choice of music, and listen to it on my old radios.

There are a lot of transmitter projects to be found in Internet-land, including lots of one-tube circuits. Unfortunately, most of the one-tube circuits use pentagrid converters which are very nonlinear by design, and tend to produce very bad sounding signals. I had a few 6M11 compactron tubes that I'd collected for another project which was never completed. So, I decided to design my own circuit using one of these tubes. A 6M11 has two triode sections, and a pentode section. I decided to use one triode for the oscillator, one triode for the audio preamp/modulator, and the pentode section for the power amplifier. Screen grid modulation is used.

Here is the schematic:



Larger Version Here

How it works

The oscillator section, V1-b, is a standard Colpitts oscillator using a ceramic resonator (or a crystal). Feedback is from the cathode circuit. The output of the oscillator section is coupled to the control grid (G1) of the pentode section. Using a separate oscillator section, provides excellent isolation from factors which might otherwise cause frequency drift or frequency modulation. In testing, I was not able to detect any FM distortion in the transmitted signal.

Audio preamp section, V1-a amplifies the audio input, and the resulting signal is DC coupled to the screen grid of pentode section V1-c through the NE-2 neon lamp. The neon lamp drops the DC level at the screen by about 50 volts without attenuating any of the audio. This voltage difference provides a good quiescent operating point for the pentode while providing a higher voltage at the triode plate. The variable resistance R1, in the triode plate adjusts the triode plate and pentode screen supply together for the best operating point. Now, the obvious question: Why use a DC coupled circuit? Why not use AC coupling and bias the stages separately to get the best operating point for each stage? The first reason was simply to minimize any

signal attenuation resulting from all of the extra bias components. The second reason is that I like neon lamps. The third reason turned out to be the accidental discovery that this type of DC coupling allows for carrier control. Carrier control is the principle of adjusting the average carrier level in a transmitter as the average modulation varies. At low levels of modulation, the average carrier value is kept to low values, and at high modulation levels, the average carrier level is increased. This reduces the average power consumption of the transmitter, but allows high peak power output when required. It also has the advantage of working as an audio expander, and reduces problems of under-modulation and over-modulation. Once adjusted properly, it’s very forgiving of changes in audio source levels.

The carrier control works as follows. The preamp grid and input coupling capacitor act as a clamp circuit. The V1-a grid is biased very close to 0 volts when no audio is present. With an audio input signal present, positive excursions of the input signal cause a very small grid current to flow, which charges the input blocking capacitor creating a more negative bias on the grid. Hence, the grid bias voltage follows the peak of the input signal, and positive peaks of the input signal are clamped to ground level. Therefore, as the audio input level increases, the grid bias goes more negative, and the average plate current decreases. When the plate current decreases, the plate voltage goes up, which in turn increases the voltage to the screen of V1-c, increasing the average carrier level. The 1 Megohm grid leak resistor in the grid circuit of V1-a provides a discharge path for the grid current and the charge on the capacitor. The value of this resistor and the value of input coupling capacitor determine the time constant of the carrier control. The values shown in the schematic seem to be optimum for correct carrier attack/decay time, and give the best sound quality.

Output from the plate of V1-c is coupled to the antenna through a pi matching network. I used a tapped coil, because I wasn’t familiar enough with antenna matching (especially with a random length antenna) to zero in on the best value. Also, the optimum inductance will vary depending on the operating frequency of the transmitter. The coil shown in the schematic covers the AM broadcast band fairly well, when coupled to reasonably short antennas (~10 feet long).

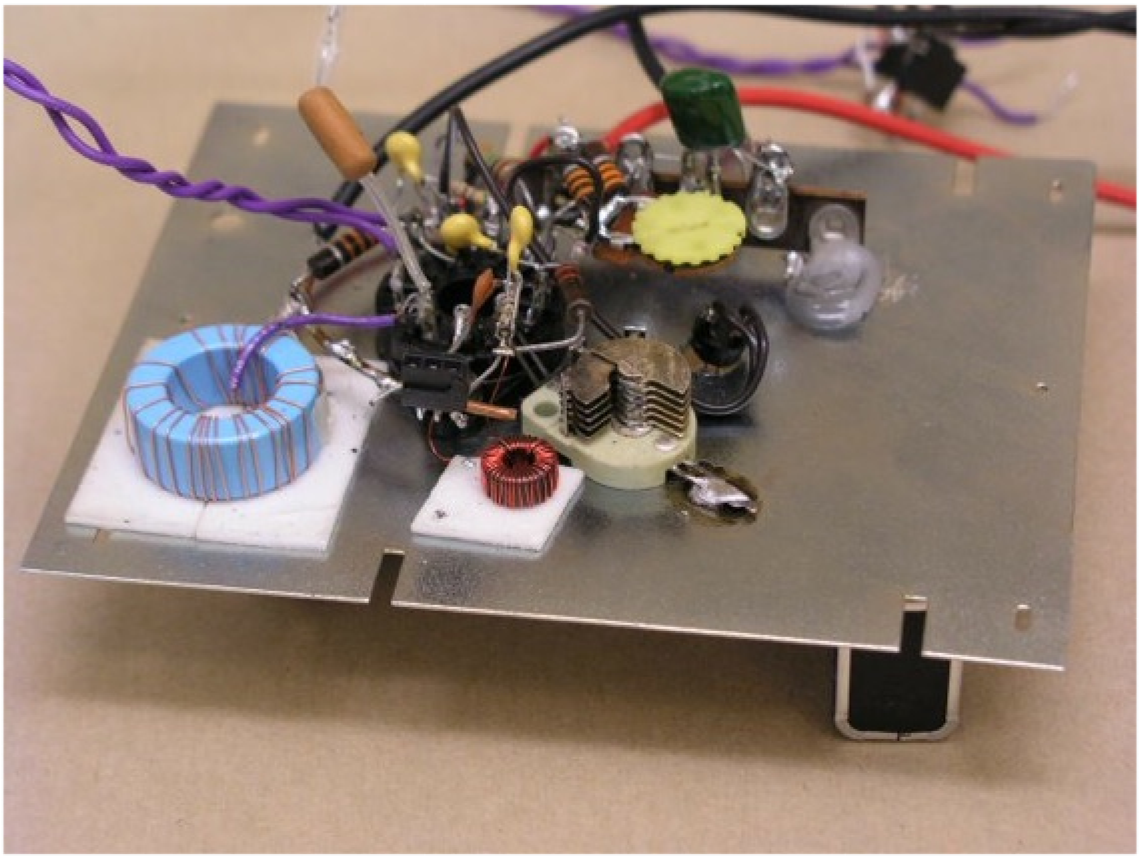
Sound quality from this transmitter is excellent. It is easily capable of delivering an acceptable signal even to hifi AM receivers. I tested this with a Sony ST-JX450A AM stereo, FM stereo tuner, which is capable of wideband AM reception. In wideband mode, the audio quality was better than what I could receive from commercial AM stations.

This transmitter does have a couple of shortcomings though. The first is that it requires a bit more than line level audio to drive it to full modulation. This could be

overcome by using an audio input transformer to increase the drive level, or add an additional preamp stage. I use an inexpensive Radio Shack mixing console which puts out enough signal to drive the transmitter quite well.

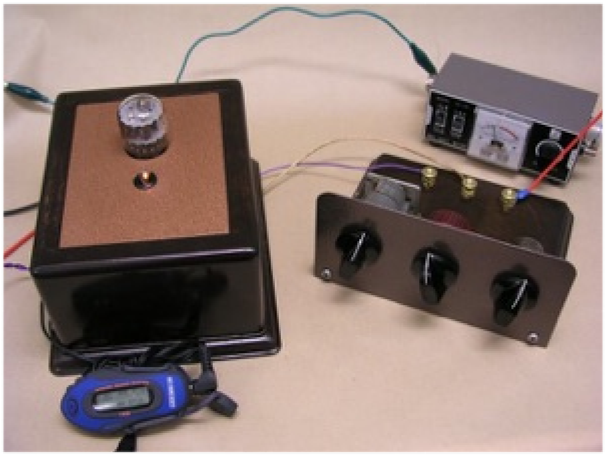
The second shortcoming is that even with three stages, this transmitter doesn't put out as strong a signal as you could get from a one tube circuit using a dual control pentode with suppressor modulation. However, it has enough output when properly matched to a 10 foot antenna to be heard over a distance of 100 feet, which is enough to get to any radio in my house.

Here is a view of the underside of the chassis:



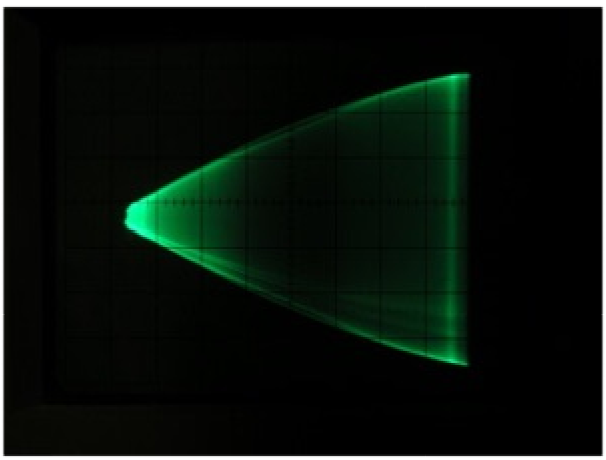
Wiring is point to point, using the tube socket for mounting many of the components. This results in very short lead lengths which is good for radio frequencies, even though it doesn't necessarily look very neat. The toroidal chokes shown in this picture were later found to be extremely lossy, and were replaced with better ones. Never use mystery ferrite! Immediately in front of the tube socket is a part of an IC socket which is used to hold the ceramic resonator, but the resonator is missing in this photo.

Here is a view showing the transmitter with the antenna matching network, which was built as a separate unit The audio source is from the MP3 player in the foreground. In the background is an inexpensive passive signal strength meter, which I used for adjusting the matching network for maximum output. Antenna



matching is a critical part of setting up any transmitter, especially something as low powered as one of these. When correctly adjusted, the amount of power to the antenna goes up dramatically, and is clearly visible on the signal strength meter. The red wire connected to the matching unit is the base end of a 10 foot wire antenna. The signal strength meter is about a foot away, and is sensing the signal with a small 4 inch built-in antenna (beyond the right side of the photo).

Here is a trapezoidal scope trace showing the modulation envelope, when at approximately 100% modulation.



Note that the curvature in the envelope indicates the presence of some distortion. This was not audible however, and I didn't consider it significant compared to the severe type of distortion which would occur from over-modulation. When the audio level is changing, the carrier control effect is very noticeable, as the zero percent modulation point on the left hand side remains stationary, and the wide full modulation part on the right, expands further to the right in time with the audio.

Antenna Matching Update - 2015-09-07

Please refer to this page for updated information about:
[Matching a Part 15 transmitter to a short antenna]
It discusses the antenna pi matching network used in the above schematic, as well as a simpler and more efficient antenna matching network.

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This page last updated: April 6, 2017

God Bless America!

N1NKM's 1-tube BTN AM Radio!

N1NKM's

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HOMEBREW!
1-tube AM radio

NOTE to modem users: this page has several 50K+ pictures, which may take a few moments to load. Please be patient.

Visitors to *THIS PAGE* since 5/27/06 :)

This page contains photos of my homebrew, 1-tube AM radio. It's a project I did just for the sake of doing it... I had the tube, so I figured "What can I make out of THIS?" so here we go...

Front view of radio

(Click each picture for LARGE view. Use BACK button to return here.)

On the left, is the Regeneration control. It works by varying the B+ to the plate of the RF stage. The optimum setting is a little below oscillation, where the audio level comes up and selectivity increases. If you increase it

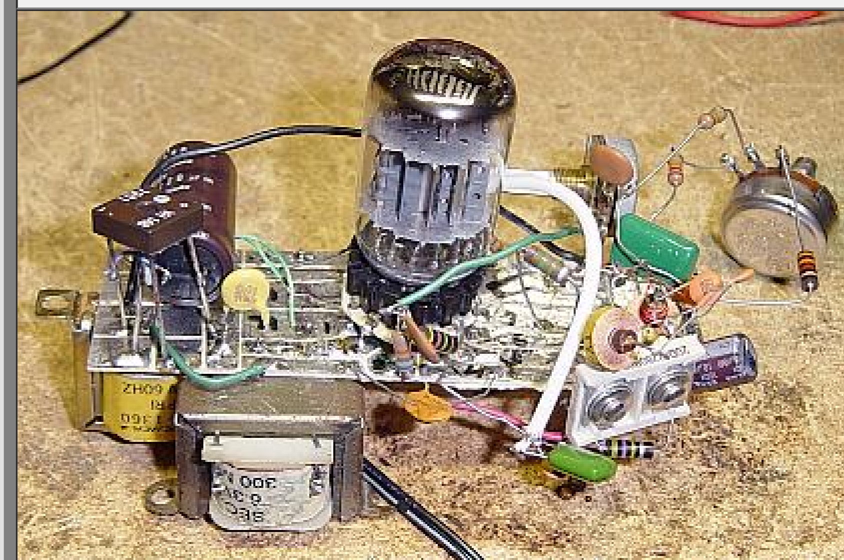
beyond this point, the audio will start to become "muddy" as the Q is multiplied, and bandwidth reduced. Continuing to increase this will cause oscillation. This can be useful for SSB or CW reception, but not for listening to AM stations. ;)

The next pot over is the volume. The yellow transformer at the right is the B+ step-up. It takes the 15VAC from the "wall-wart" and steps it up to about 140v. This is plenty to get very good performance from this rather simple radio!

There is a point to be careful, with pins 2 & 3! Pin 2 is the pentode plate, and 3 is the center triode's grid. In this circuit, that would make an ideal feedback path between the output and the 1'st audio stage input, so layout is critical, here.

The unusual-looking breadboard is homebrew. I took a piece of plain PC board, and etched the pattern with a small, pointy file. Then I tinned it with solder, added the socket and then the components. The cathode resistor of the pentode was done by "lifting" the tube socket's pin from the board, and putting the R between the pin & the board. This simplified the rest of the layout, as I could use the larger foil area as a convenient ground.

Back view of radio

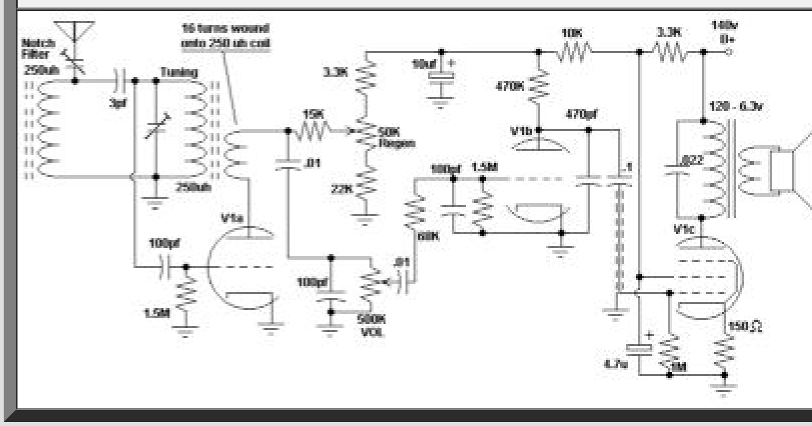


Here's the backside view. The 6.3v transformer is the audio output to the speaker. The dual trimcap is the radio's tuning and band-reject filter. Because I live only about a mile away from two AM stations on 1300 and 1340, their signals are quite strong. This first trimcap & coil form a series-resonant ckt, to shunt those stations signals to ground, while allowing other signals thru. The other trimcap is the tuning control for the radio. This radio is intended to be a monitor, where you set it to the desired station and just leave it set there. It works quite nicely in that capacity! (It needs an external wire antenna. I use a nearby metal shelf, which works perfectly.)

Bottom view of radio

For this bottom view, I decided to include the "wall-wart" in the picture. It's a 15VAC, 1-amp unit, which is just about right for this application. The foil shield on the bottom is simply a piece of aluminum tape. A small piece of wire from the component side is bent around to make contact with this shield. That helped to stabilize the radio.

Schematic of 1-tube radio.



(Click for full-size schematic)

Although this is a pretty basic design, it's customized to work with this particular tube & it's unusual "breadboard" layout. The power supply is not included in the schematic, since ANY source of 15V & 140v can be used.

If I can get my hands on another one of these tubes (or similar) I may make a small AM transmitter out of it! :)

You are welcome to [E-mail me] with comments/suggestions.
Constructive messages are welcome.
Abusive messages will be deleted. It's that simple. :)

Here's my HOME page

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This information is presented as educational information only. No guarantee is made as to its fitness for any purpose. All risk is assumed by the person who choses to use this information.

20m Loop Antenna

by Harry Lythall - SM0VPO

Introduction

I recently saw that my 80m (3.5MHz) loop (or frame) antenna has been really popular, and that there are loads of other radio amateurs who have taken my design and *"ran with it"* to produce variations that all have some great improvement. There have been many in-depth tests and simulations, all with exceedingly good results and reports. This is exactly what I am aiming for with my homepages - free information for all and my designs being improved upon. That way we all win :-)

One small point all varaitions have in common is the need for an expensive tuning capacitor and a very restricted RF power level. Of course, you can throw money at the problem, but for me this hurts. I got to thinking that there must be a way of adjusting the design a little and finding another technique to tune the antenna, and to make the best use of the little radio transciever I have in Sweden, given the limited space.

My limited space apartment.

As you can see there is not much opportunity for grand antennas. And to add to this, the equipment I have in Sweden is also limited to a single 5-Watt unit.

My limited equipment - only 5-Watts.

The Design Thoughts

Today I have no area of land to use for antennas. I have a glassed-in balcony on the 4th floor of an apartment block. I really like the 20m (14MHz) band so I will concentrate on that. I am not really interested in the CW end of the band, except perhaps 14.070MHz for the digimodes. So my requirements are:

- As efficient as possible (useable)
- Small size, also portable so I can use it for field use
- No expensive components, everything available locally
- No TVI, QRM or interference to stereos or computer sound
- Total price less than $2

The antenna I have created is based on my original 3.5MHz [loop (or frame) antenna](). This time I built it out of scrap components. I [cadged]() (tiggade) some plastic conduit tubes from an electrical contractor at work. The same guy also gave me the remnants of a roll of 2.5mm C.S.A. multi-strand mains cable. That was all I needed.

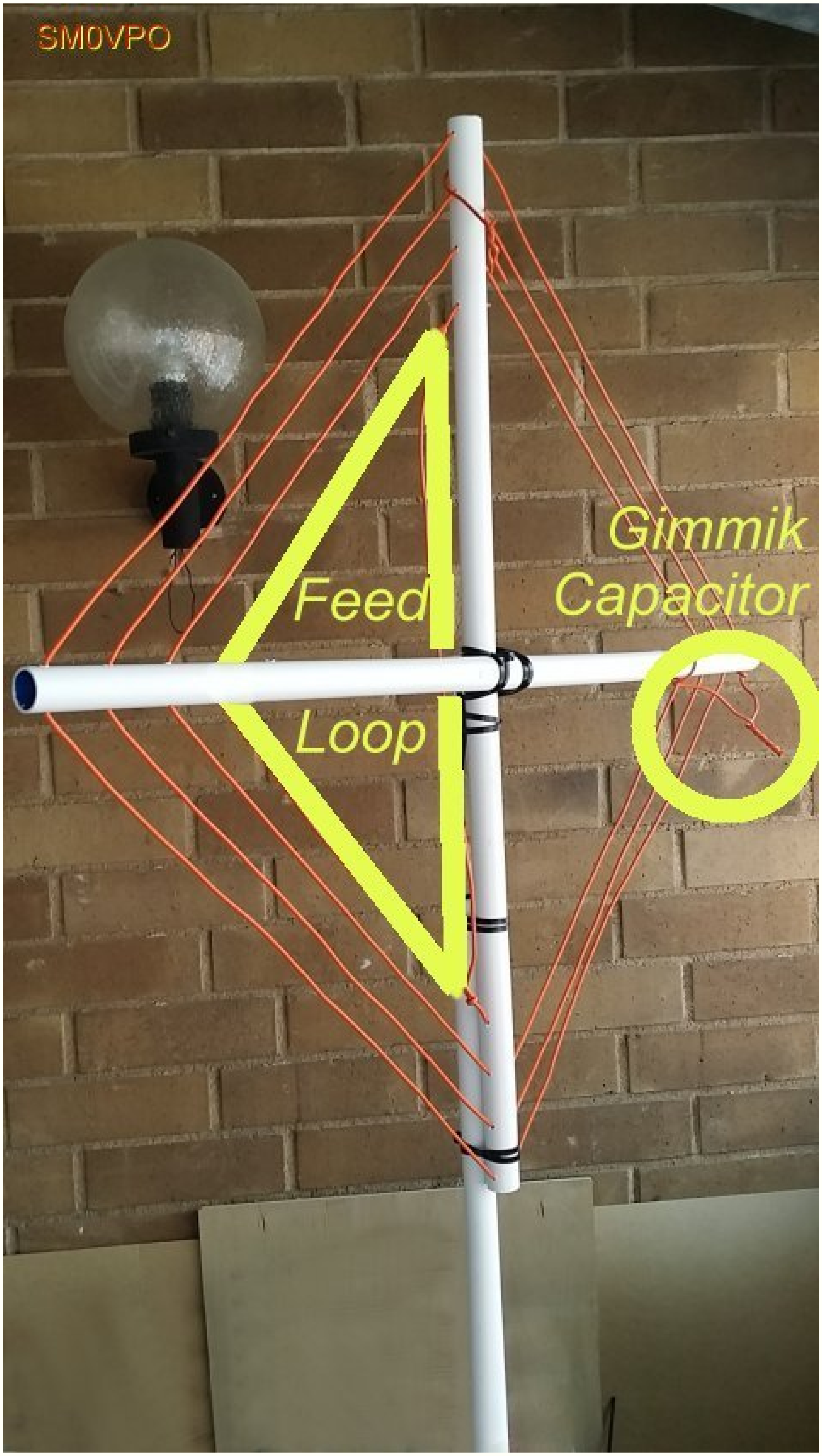
In my junkbox I found no tuning capacitors, but WAIT!! Why do I need to tune the antenna? Once it is tuned I should not need to tune it again, just set the centre-frequency to 14.175MHz. If I can get the Q-factor to around 100 then my useable 3dB bandwidth should be more than 150kHz. That will give me 14.10MHz to 14.25MHz.

Ok, I need a 1-off, preset tuning capacitor. Why not use a Gimmik Capacitor? Just twist two bits of wire together and cut it short to get the resonant frequency I want. So I need to get the coil wound so that there is sufficient cable length and self capacitance to give a resonance of about 14.5MHz without any extra capacitance what-so-ever. That means I need just a few pf. That sounds like a good plan.

Construction

The 15mm Diameter plastic tube I "aquired" were 80cm long. After much trial and error I found that exactly 3 turns, with 2.5cm spacing, gives about 14.9MHz self resonance. The wire support holes are exactly 4cm spaced,

beginning 1cm from the end of each tube. The two tubes are fixed into a and X using zip-straps (tie-wraps, buntband). The feed loop is 1/2 turn.

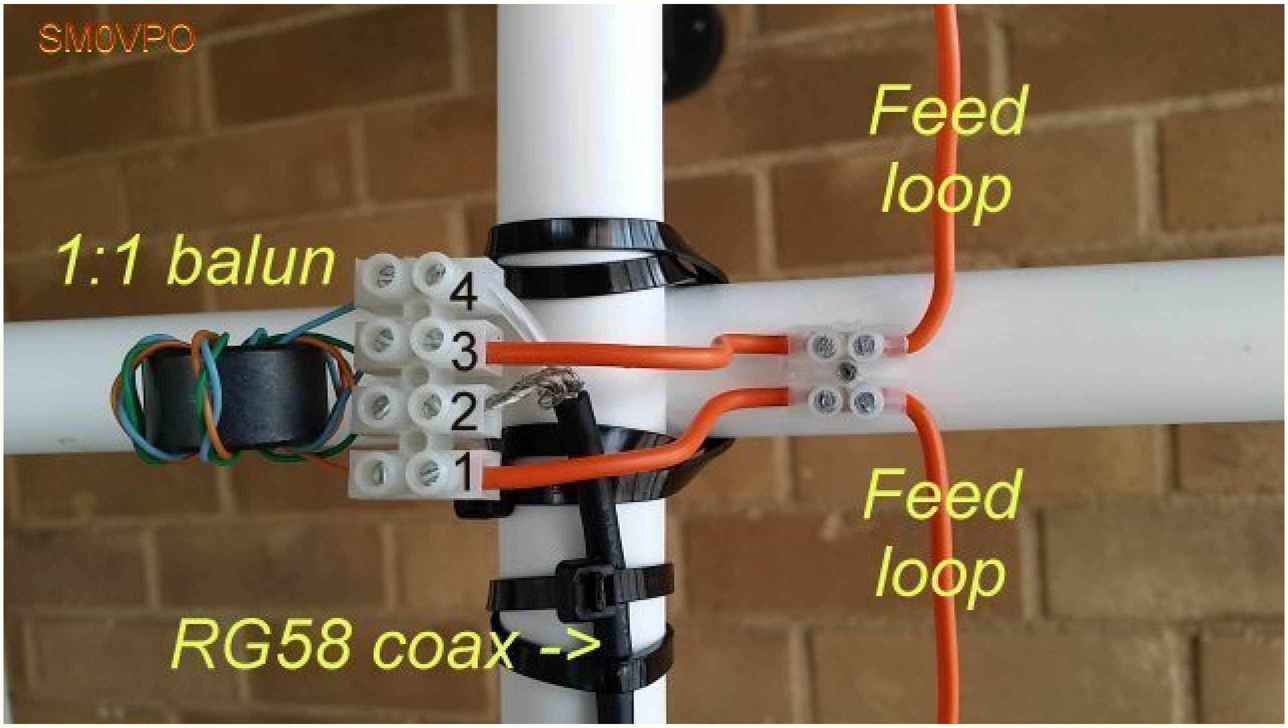


Note the size and position of the feed loop. Also the Gimmik capacitor.

One problem I had with the original loop antenna was that of RF coming back down the cable braid. Using on old FT-101ZD it was possible to feel the RF on the microphone with your lips. The cure for this is to use a

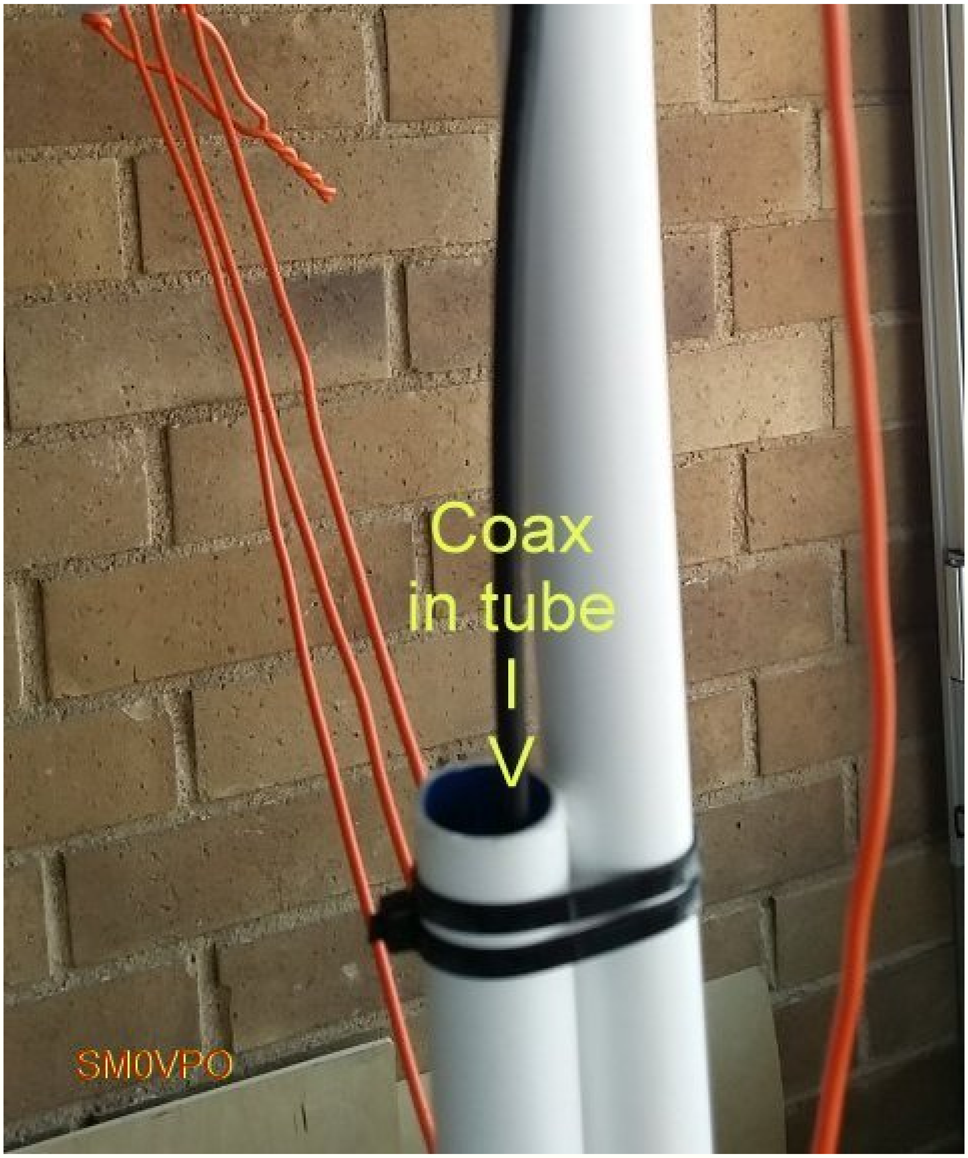
balanced feed and at least 5m of RF cable.

I robbed the ferrite ring for the balun from an old ATX computer PSU and made a triflar wound torroidal transformer. That is to say, twist together three lengths of 1mm x 7-strand insulated hookup wire together. Use this to make a 7-turn coil and connect the three coils in series, with four connections. Feed connections (numbered in the picture below) 1 and 3 are connected to to the antenna feed loop. Connect the coaxial cable braid to connection 2, and the coax centre to connection 4. My balun is self-supported on the connection leads.



The 1:1 Balun I used.

The coaxial feed cable was found to affect the resonance slightly, so I fed that through an extra bit of tube to make it stay in one place. It works fine.



Feeder cable secured in the support tube.

Testing

Testing is very easy. I used my GDO-2 to check the middle-turn of the loop for a dip. Twist the two tails together to form the Gimmik capacitor and adjust the length of the twist until the centre-frequency is 14.175MHz. With the GDO you can get it within about 100kHz to 200kHz, but then you can check the VSWR using your HF radio. You can also sweep the band for maximum noise and get a very close approximation.

The Gimmick capacitor.

The centre.frequency of my 20m Loop antenna is 14.175MHz, and the VSWR is better than 1.05:1 (I can hardly see any movement on my meter). The Q-factor is somewhere aproaching 100. The useable bandwidth is just a little narrower than I would have wished, but the antenna certainly works well and meets all the other criteria. But the slightly less useable bandwidth criterion is at the expense of better performance, and it still allows me to use 14.070MHz, although it is a little quiter down there.

Frequency	VSWR
14.010	3:1
14.095	2:1
14.130	1.5:1
14.175	1:1
14.220	1.5:1
14.260	2:1
14.325	3:1

The completed antenna.

Conclusion

No-matter how you play with the figures, the best indoor antenna cannot replace a full-size dipole antenna. But the indoor antenna can give some extra features, such as just reaching out your arm and trimming a little, which you cannot do with a long-wire antenna up a tree out in the garden, especially when it is raining.

This antenna gets me on the air on 14MHz, and it has a useable frequency range. The VSWR is almost perfect at the centre-frequency, and this time I don't burn my lips on the microphone (not that I am likely to do so with just 5-Watts of power). The design uses no expensive components, in fact the only item I bought was the block-connector for the balun. That cost me US$1.50 for a pair of 12-contact screw-terminals. The construction is ridiculously simple and easy to build.

On the air I can hear traffic on 14.070 digimodes, and from 14.130 to 14.220MHz I have a near-perfect VSWR aqnd good clear reception of SSB. I can also rotate the antenna to cut out rubbish, and most of all, using the Gimmik capacitor I don't need to re-tune it: it seems temperatore-stable. The weight is less than 500g and when I poke it out of the balcony window the reception improves, the VSWR does not change, and I can make myself heard among the big boys.

I hope that you have some fun building and using this antenna. If you have any ideas for further improving it then please use my forum.

Dont forget to visit my messageboard if you have any questions about this or any other project. I always look forward to receiving feedback, positive or negative.

Very best regards from Harry Lythall
SM0VPO (QRA = JO89WO), Märsta, Sweden.
EA/SM0VPO (QRA = IM86BS), Nerja, Spain.

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30m QRP transceiver – Part 3

Posted on 7 April 2014 by Ernest

Receiver part of the 30m QRP transceiver. From left to right: preselector, 1st mixer, IF filter, 2nd mixer, 8 MHz oscillator

Now all LF parts and the VFO were finished, it was time to build the RF-part of the receiver.

This receiver consists of multiple sections. The first section is the (fixed) preselector, which is a combination of a bandpass filter for 10 MHz and a band reject filter for 6 MHz. The 6 MHz band must be filtered out, since this band contains lots of strong AM broadcast stations and is also the mirror frequency for this receiver: the input signal is mixed with the 2.10-2.15 MHz VFO frequency. The 10 MHz band is mixed down to the 8 MHz IF (10.1 – 2.1 = 8 MHz). simultaneously 6 MHz is mixed up to 8 MHz (5.9 + 2.1 = 8 MHz), disturbing our reception. So getting rid of the 6 MHz is very important.

I soldered each mixer (SA612) onto a very small part of breadboard (6×4 pads), with the solder side upward. Then I put the breadboard on my desk and placed the DIL-8 packaged chip in the center. Along each row of pins a row of pads remains unused for the moment. The pins of the chip line up with the (normally) component side of the board. Then I soldered the pins to the pads, with the chip package on a small distance of the board. Finally I soldered the directly connected components on the unused pads (through-hole mounting is not necessary) and connected them to the corresponding pin.

Just behind the first mixer is the IF filter. This is made of 3 crystals of 8 MHz. The output of the filter is inserted in a second mixer with an 8 MHz fixed oscillator. The output is the LF signal, ready to be inserted into the LF filter and amplifier.

I managed to put the preselector, IF filter, both mixers and the 8 MHz oscillator at a small piece of copper clad, which measures only 7×3 cm. See the pictures how I did this!

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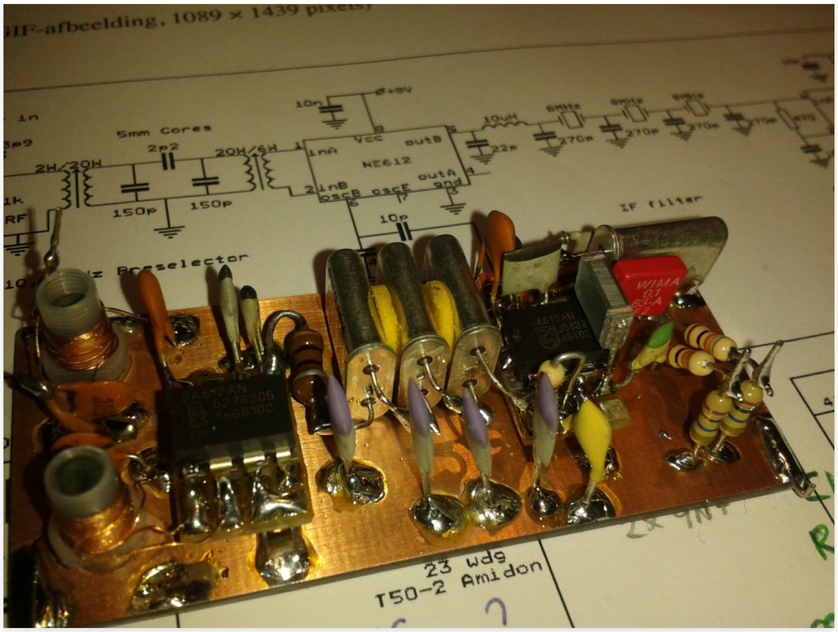

Another view of the receiver part of the 30m QRP transceiver.

Posted in Transmitters and receivers | Tagged 30m, 40-30, cw, manhattan-style, qrp, transceiver | Leave a reply

← 30m QRP transceiver – Part 2 Best dutch participant in AGCW contest →

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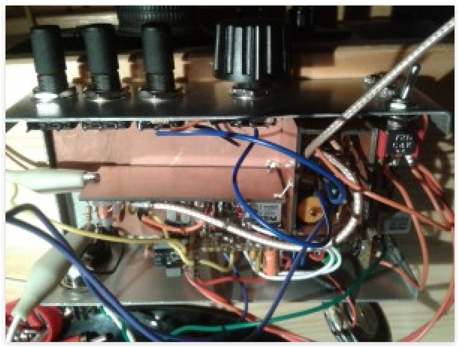
30m QRP transceiver – Part 4

Posted on 3 July 2014 by Ernest

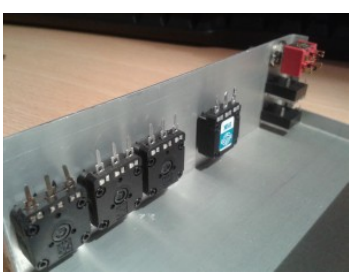
Since I finished all modules for the receiver part (power, LF, VFO and RX-board), it was getting time to put everything together and place it in a nice case. Onno PA2OHH (designer of this radio) managed to put the complete transceiver in a single Teko 4B case, so I ordered that same box. Actually I already bought it at the beginning of the project, to help me dimensioning the modules. With such limited space, planning the physical layout of the radio (both the front panel and the inside) is very important.


Inside view of the radio, including all modules built so far.

Before putting all modules in the case, first some mechanical work had to be done. I drilled holes at the desired locations and placed all connectors, switches and potmeters. The location of these components was a precise job, since it should perfectly fit together with all the modules inside. After some hours of drilling and screwing the case was ready.


Front panel view. Left: 3-position switch (off, on, on+marker), connectors for key and phones. Middle: VFO dial. Right: RIT, RX-gain, volume.


Rear side, with BNC-connector to attach the antenna, and a DC-connector for power inlet (9-14Vdc).


Inside view.


I had to modify the potmeter axis to fit the dials.

To place all modules in the box, I made some kind of main board, which happened to be a simple piece of copper clad. I started with cutting a rectangular board, perfectly fitting at the bottom of the case. Then I cut away some corners/edges to allow placing and removing it without having to

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remove all connectors, switches and potmeters from the case. The idea is that all electronics can be “lifted” from the case to allow easy repair and maintenance. Of course, all leads between the electronics and the parts fixed to the case have to be long enough to allow the board to be lifted. I also made two small stand-offs to support the (lifted) main board.

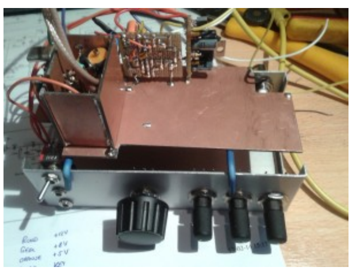
Next I placed all modules on the main board. I provided each module with some small pins (pieces of wire, e.g. cut-off resistor leads) at one side. By facing that side down and putting it on the main board, each module could easily be mounted by soldering the module’s pins to the board. I placed some additional wires between the modules for extra mechanical support, to ensure the modules can’t touch each other (short circuit prevention).

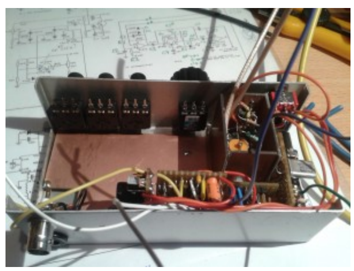
To test the receiver, I connected all modules to the power module. Most modules require one or more DC voltages (12, 8 and/or 5 volt). Other connections include signals going from one module to another, and connections to connectors, switches and potmeters fixed to the case. I applied 12V power to the box and verified the total current (about 13mA). No smoke signals, so everything was looking good.

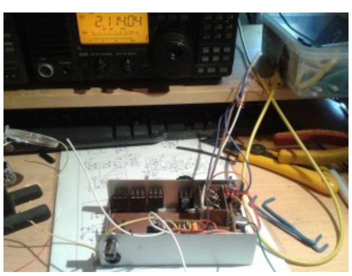
I attached a small speaker to the LF amplifier module and put my finger on the input to insert some noise; the noise came out of the speaker, so the amp seemed to work. Next I inserted a small signal at the antenna input (using the generator feature of my MiniVNA) and tuned the VFO to hear the carrier. I tuned the preselector, the carrier was really loud so I lowered the input signal and turned the coils of the preselector again to obtain the best signal.

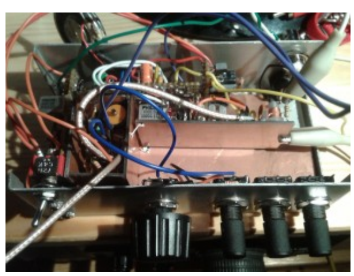
Since the marker generator was ready too, I powered it on and turned the VFO knob, every 10kHz a small carrier was present, proving the marker generator works nicely.

The final test: I attached a couple of meters of wire to the antenna input and turned the VFO dial again. I was able to receive a couple of RTTY and CW stations, proving that the receiver really works. Since I didn’t have a proper antenna for 30m yet, I was not able to determine if the receiver is really hot, but I was very happy I actually received some stations already.


Lifted main board.


Main board with modules, inserted in the case.


Callibrating the VFO using a commercial rig (Icom IC-718).


Inside view of the radio, including all modules built so far.

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30m QRP transceiver – Part 5

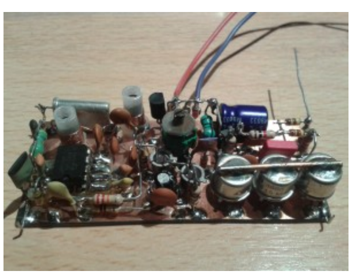
Posted on 19 August 2014 by Ernest

Final shot of the rig, including labels, key and headphones.

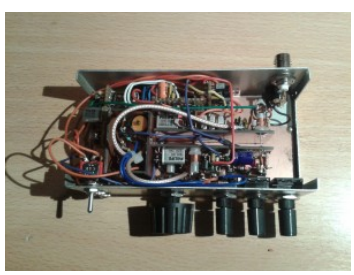
Since the VFO, LF and receiver seem to work without any problems, it was getting time to build the final parts: the transmitter board, the transmit/receive-switch and the lowpass filter.

The transmitter is very easy to understand. It all starts with a VFO signal (2.100 … 2.150 MHz), mixed with an 8 MHz signal (xtal oscillator) by yet another NE612. The output signal of the mixer includes the sum frequency, which will be the carrier. Because the mixer also produces some other frequencies (e.g. 8 – 2.1 = 5.9 MHz) the mixer output is followed by a bandpass filter. The clean carrier is amplified by 3 stages. The final stage is a C-class transistor amplifier with 3 transistors parallel connected. The output is connected to the TX/RX switch, there was just enough space left on the board to include that circuit part. The transmitter board (just another piece of copper clad) has the same size as the receiver board, allowing to put them back-to-back in the case.

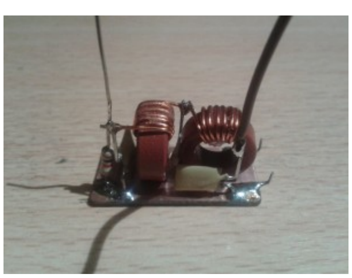
I still had some room left in the case, more than enough to house the lowpass filter. I built it on another small piece of copper clad. Since I worried a bit about the power characteristics of those resistor-shaped inductors I made these myself, each inductor made of 8 turns of shielded copper wire on a T50-2 core.



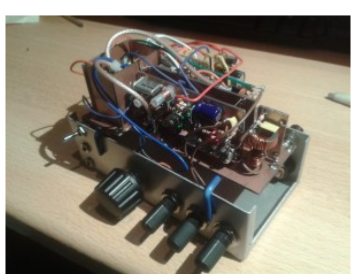
The transmitter board, from left to right: mixer with 8 MHz oscillator, first stage, second stage, final stage, TX/RX-switch.



Thanks to my compact building work enough space remains available for a PI-filter and future extensions.



The PI-filter.



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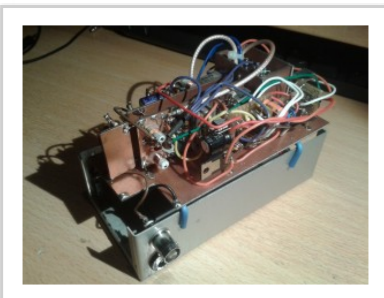
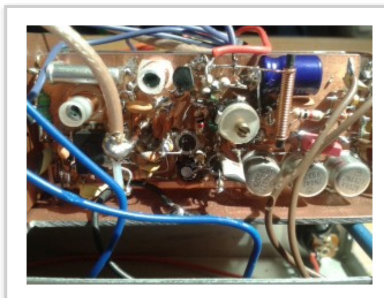
All parts in place, all boards connected, ready to put into the case.

When testing the transmitter board there was no output, and it drew just a few milliamps, so something was terribly wrong. I fired up my oscilloscope and soon found out that the 8 MHz crystal oscillator wasn't running, caused by a broken NE612 mixer. I replaced the chip and the oscillator was running now. However, there was still no output… I turned around the cores and variable capacitor many times, but whenever I touched the morse key the needle of my power meter did not move. It was getting late so I turned of my soldering iron and went to bed.

The next evening I did some more measuring, testing and reading. I found out that the first 2 stages operated very nicely, but the final stage (3x 2N3866 parallel) was not waking up. I tried to increase that input signal by slightly modifying the first 2 stages, without success. Then I read the datasheet of the 2N3866 and 2N4427 transistors again and found out that its emitter-base voltage is about 3.5 volts, while the 2N4427 (almost identical to the 2N3866) requires only 2.0 volts. I immediately ordered a bunch of 2N4427's. Two days later they were delivered and I rebuilt the final stage. I pressed the morse key once more, looked up a bit nervously to the power meter. And yes! About 1 watt of power was leaving the rig and heating up the small dummyload.


Rear view of the completed electronics.


The modified transmitter board, now with the 2N4427's installed.


The box is closed!


Jan PA1JT offered me this cute tiny morse key, perfect for backpacking!

The transceiver is ready now. It was a very nice project to do. The construction with all those small boards happened to be very successful. The radio can be serviced easily by lifting the mainboard and removing/isolating one of the modules. The reception is great, the IF-filter is very nice. The VFO is very stable, I can just power on the radio and almost immediately start operating.

Still, there are a couple of things that I might improve in the near future:

- The sidetone is rather loud compared to the received signal.
- I would have expected a bit more output power. A single 2N4427 has a maximum output power rating of 1 watt, so 3 should easily provide 2 watts. I'm thinking about adding a small capacitor parallel to the 100 ohm resistor in the second stage (emitter of the second 2N2222).

For now the box is ready to prove itself. The first occurance will be my holiday to Scotland, during a hike in the beautiful Highlands. Maybe I will do some SOTA activation too.

I finish this final part by saying thank you to Onno PA2OHH for his publication of this great little "NiceRig" 40-30.

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October 2002 (1)
August 2002 (1)

Important notice

This is my personal website, it reflects my personal opinion and has no relation to my job or whatsoever.
An appropriate amateur radio license is required to own and/or build and/or use the transmitters described on this website, depending on local regulations.

Final shot of the rig, including labels, key and headphones.

Jan PA3EGH made an audio recording of my radio signal when I was on holiday in Scotland. This recording demonstrates the stability and clear tone of the transmitter:

00:00 00:00

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Working with 230Vac

Your reference guide to working with 230Vac or 110Vac High Voltage Electricity.

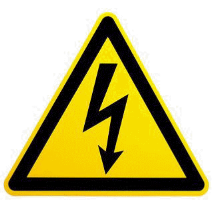
Edited by Lim Siong Boon, last dated 29-Aug-09.

email: mail@siongboon.com
website: http://www.siongboon.com

Content 230Vac

1. Safety
2. Signal and Measurement
3. Working with 230Vac electronics
4. AC lightings wiring guide

1. Safety



Introduction

The objective of this site is to get to know about the electronics components that can help us control 230Vac devices. Devices like ac lamps/lightings, power sockets/supply, heater, and many many other appliances at home. We are all surrounded by many appliances operating directly from AC mains supply. It is very interesting to control and work with these appliances. Learning to control with electronics, microcontroller and computer.

Our home is typically pre-installed with 230Vac sockets. The socket where we obtain our electrical power source. It is this basic utilities that keeps us operating in this urbanization era. Different country implement their own AC voltage system & AC plug. The electrical delivered to our home wall socket is a 230Vac single phase ac power. So throughout the section, we will only talk about single phase system and not the three phase system.

The first thing in my mind when it comes to 230Vac is "Dangerous"!!! I am still very scare of it. One careless mistake and we might not have a second chance to try again. Some article suggests that a voltage over 30V is considered as danger. Lower voltage is relatively safe to touch with your bare hand, although sometimes you may get the shock sensation on your muscle.

230Vac is a dangerous stuff, but when working with electronics you can hardly avoid using it. And when we cannot avoid it, then we have to face it. Facing it, by understanding more about it. Minimizing our chance of getting killed by 230Vac. So let us pay careful attention to this section.

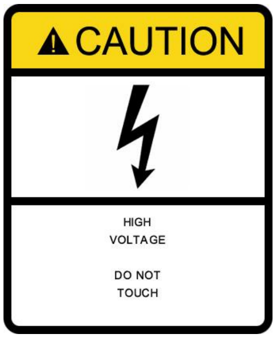
The following article is from a website with simple illustration of electrical safety. It explains in simple terms the difference between birds and human touching the same high voltages cable. Why birds don't get electrocuted? How do we get electrocuted? From these two question, we get to understand more about voltages and how we should deal with them to protect ourselves. Safety first, which is why I put this as the first section.

- electrical safety.pdf

http://www.eng.cam.ac.uk/DesignOffice/mdp/electric_web/DC/DC_3.html

Remember that we will not have any chance to try again. Understanding the danger of electrical earth path will minimize the chance of getting electrocuted.

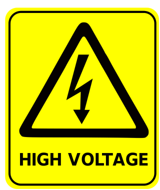
Before touching any wire, be sure to measure and ensure that there are no "live" voltage on the wire. You can use a multi-meter or test pen to check for live connection.




Multi-meter. Measure between the "live" and "nuetral" line to check if 230Vac is present.


Test Pen (this test pen comes in the form of a slotted screw driver. You can see a small bulb embedded in the handle. Touch the suspected "live" wire with the tip of the screw driver. Locate the back of the handle for a metal plate. If the bulb inside the handle lit up, when you touch your finger to the metal plate, it means that the wire is "live".

reference:
Electrical System around the world,
- http://kropla.com/electric2.htm
Electrical Safety,
- http://www.eng.cam.ac.uk/DesignOffice/mdp/electric_web/DC/DC_3.html or electrical safety.pdf
- http://www.allaboutcircuits.com/worksheets/shock.html



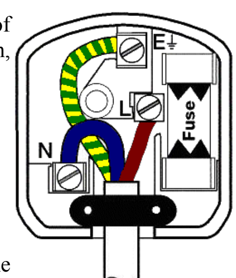
Electrical box install at home..

Bigger electrical box install at office...

Various names: Electrical box, DB box, Electrical distribution panel, Control panel

On the left are some of the common electrical box that we may find in our home. They are the main electrical distribution point to all the other rooms. From the power station to the sub-station and then to this box, distributing electrical power to our rooms.

This Type-G plug distributed to our rooms, consist of 3 cable namely Live (hot, brown), Neutral (return, blue) and Earth (safety ground, yellow/green).



Click here for other plug type.

On the electrical box, we can see a row of switch. One main switch is particular unique in color or size. This is the main switch which cut off the supply from live and neutral wire. The rest of the switches, only the live wire is disconnected. This is an important note to take, and the same applies to the wall switches. When we switch off the light or appliances, only the "Live" wire is disconnected.

There was once I was working on a power supply unit. Wanting to doing rewiring, I switch off the power leaving the 3 pin plug on the socket. I have carefully unscrewed and pull out the earth wire. Thinking that it is now safe that I have switch off the AC socket, I become relax and casually removed the earth cable. The earth wire accidentally touches the neutral wire and phow, my whole office got black out. From then on, I remember that neutral wire is as alive as the live wire. Never treat it lightly. When you switched off the power to do maintenance work, do not assume that the live as well as neutral is disconnected. Always check and handle them with care. Insulate the bare wire if you are unsure. Assume that they are always alive, unless you are absolutely 100% sure that the wire is unplugged from the power system. 99% is not good enough. It has to be 100%.

MCB (miniature circuit breaker) to protect the electrical line from over current drawn. RCB (residual current breaker) similar to MCD is another protection device trips when electrical leakage is detector (incoming current != outgoing current). Some device has both the features of MCD & RCD. They normally comes in the standard DIN rail mounting for the electrical boxes.

Other name: ELCB, MCCB, RCD, RCCB, RCCD (residual current circuit breaker), ground fault circuit interrupter (GFCI), ground fault interrupter (GFI) or an appliance leakage current interrupter (ALCI), safety switches, "salvavita" (life saver).

It is recommended to install a circuit breaker (MCB) as well as a residual current breaker RCB when working with AC devices/equipments under test. They can protect against accidental over current or leakage fault that occur. Anything goes wrong, the device will be tripped, cutting off the power supply from the mains, protecting us from possible electrical shock.

RCB is more important as a protection from serious electrical shock. During normal operation, the current to and from the live and neutral wire should be equal. Any different in current indicates leakage. The device detects the leakage and trip the supply source.

MCB is more to cut off supply on overloading load. Example would be a short circuit from a faulty equipment. If the supply is not cut in time, the huge current pumping through will heat up the cable, resulting in fire along the cable.

There was once I am working on an automated swing door system. I try to cover back the aluminum cover, but find difficulty putting it back in position. Not knowing why there was this small gap, I bang on the cover trying my luck to close it up. Suddenly I felt a very loud bang and bright light flashes over me, followed shortly by a slight breeze. They were the result of the small explosion.

After investigating, I found out the the casing actually cuts through the AC cable resulting in a short circuit. The cable were not properly secure in a safe position and the cover finishing is badly done. The edge will not filed and has a very sharp edge. It is lucky that I remembered to connect the earth wire to the aluminum cover, else I would have being shocked. So as you see, it is important to earth the metal surface that are near the AC line.

The MCB is found to be tripped, and some burn mark can be seen around the place of impact. The MCD is trip almost instantly, but the 3 pin AC plug for the automation door is still badly burned. When I open up the plug, the interior is completely burned out. Wire and fuse all black with carbon. I have to spent another hour to repair the cable & plug, tied the cable in place, smoothen the cover edges. A lesson to learn. Proper installation not only protects ourselves and it also minimize re-work.

In this scenario, the earth wire and MCB have done their job very well. You may have installed these protect in place, but without proper knowledge of how they are going to protect you, you are just as vulnerable. Learning how to protect yourself is the most important.

Power Distribution Components, MCB, RCB, Switches

hager MOELLER

Schneider Electric Merlin Gerin

ABB

A normal electrical switch. (no protection function)

The switch on the left may looks like MCB or RCD. It function as a simple single pole switch, and offers no protection at all. They are typical used to disconnect the live wire inside the electrical box, switching off the devices just like a wall switch.

lockable switch for tagout purpose

Some models comes with a lockable design, for user to tagout. This is to minimize any chance of people unknowingly switch on the power, when the user is doing the maintenance work.

Single Pole MCB explain Curve Types

Surge current can be higher than steady state current, especially for inductive/capacitive load. Eg. motors. The surge higher than the current limit set, can easily trip the MCB. This means that it can be difficult to switch on a motor for example, because a surge from the motor startup can easily trip the circuit breaker.

This call for special MCB which has a wider allowance for surge current. MCB comes in various curve type, each has its torlerrence for surge current.

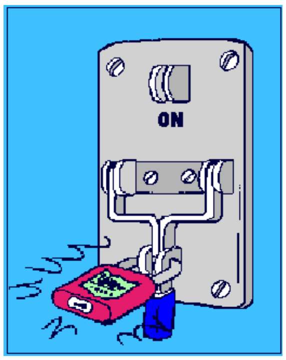
The photo on the left shows 3x MCB type (red color lever) having a circuit breaking current of 10 ampere, namely B10, C10, D10. Each of them has the same current limit. The type B, C or D curve indicates their ability to withstand sudden power on surge current.

MCB type B curve - Can withstand a surge current of about 3-5 times its rated current limit. For this MCB B10, the rate current limit is 10A. So this means that the MCB can withstand up to about 30-50A of surge current within the initial millisecond time.

MCB type C curve - Can withstand a surge current of about 5-10 times its rated current limit. For this MCB B10, the rate current limit is 10A. So this means that the MCB can withstand up to about 50-100A of surge current within the initial millisecond time.

MCB type D curve - Can withstand a surge current of about 10-20 times its rated current limit. For this MCB B10, the rate current limit is 10A. So this means that the MCB can withstand up to about 100-200A of surge current within the initial millisecond time.

There is another single pole MCB B16 in the picture. This MCB breaks the circuit when the current is over 16A. The MCB is of type B, meaning it can withstand the initial surge current of about 48-80A.



Industrial safety practice

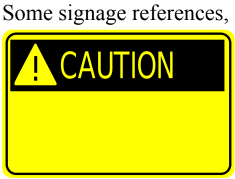
When servicing AC socket or equipment, ensure that the AC source at the electrical box is switched off. If possible, unplug from the AC socket.

Lockout/Tagout procedure should be practice strictly. This is important when we work outside because we may not be the only person operating the equipment. Lockout/Tagout involve locking and tagging the switch source. So you can be sure that no other people can switch the power back on, when you are working on the socket or equipment. It is a safety procedure. If you do not have the facilities to lock out the power, a sign board or labeling warning is advise to prevent any accidental switched on.

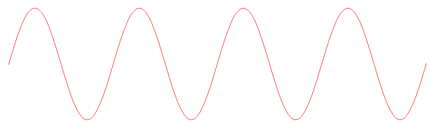
For your own safety, the procedure is worth the trouble.

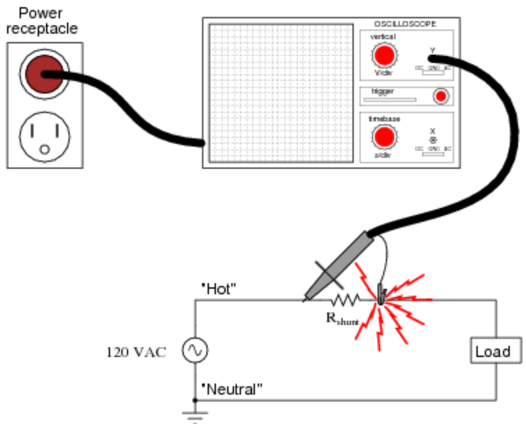
As what I have experience, AC power is actually quite dangerous. It is very important that you equip yourself with the knowledge and know-how to protect yourself against any electrocuted accident. Safety is the most important. Always treat it as through it is the first you have touch it.

Some signage references,

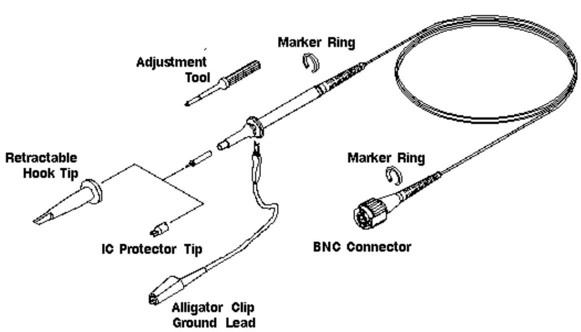


2. Signal and Measurement





graphic taken from:
http://www.allaboutcircuits.com/worksheets/scope1.html



graphic taken from:
http://oscilloscope-tutorials.com/oscilloscope/Setting.asp

Measuring the mains using digital multimeter. Reading is 230Vrms

Measuring Voltage

There is once I wanted to measure the AC signal using my oscilloscope from the mains. I am curious to look at the sine wave from the wall socket mains. Tack, all the offices around me had their power tripped.

I made a Mistake?..... I don't even know why? I was lucky that I took extreme precaution during the measurement.

It is then that I started to re-visit 230Vac to understand more about it. I realized that our oscilloscope ground clip is actually connected to the earth as reference. Which is why the power trip, when I clip the ground lead to the neutral line. When this earth clip touches the neutral wire, the extra electricity leakage tripped the MCB (Miniature Circuit Breakers) found inside our electrical box. This is a safety feature to protect us. So remember that the Earth line is connected to the ground lead of the oscilloscope probe. Be careful.

Does this means that we cannot measure the ac waveform using the oscilloscope? How do we do the measurement then?

From what I found out, there are various methods to measure. Differential method to measure the AC signal would be more appropriate. Two probe would be required, placing across the signal you ant to measure. Ground lead can be floating, which the reference is earth because the ground lead is connected to the earth line. The difference between the two probe channel would be the actual AC signal. With help from the typical oscilloscope feature, the signal can be obtain as a single waveform ploy on the screen. One of the channel need to invert (using the INV function), and both the channel are added (using the ADD function).

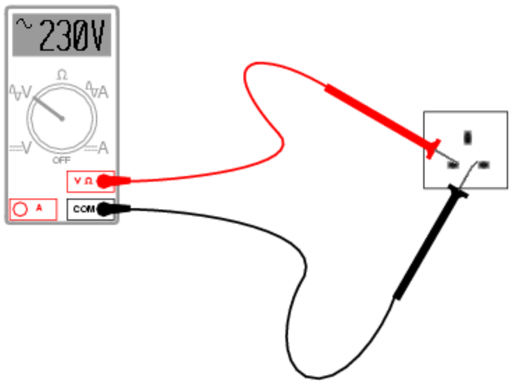
Measurement technique
- A Shortish Guide to Using an Oscilloscope.pdf
- Floating Oscilloscope Measurements.pdf
- Fundamentals of Floating Measurements and Isolated Input Oscilloscopes.pdf
- http://idobartana.com/hakb/oscope.htm (10x probe to measure high voltage)

Oscilloscope guide from other site,
- XYZs of Oscilloscopes, Tektronix 03W_8605_2.pdf
- Basic oscilloscope operation.pdf- http://www.best-microcontroller-projects.com/how-to-use-an-oscilloscope.html

Seldom typical engineer like us need to examine the AC signal. Those power engineering people who wanted to measure the signal probably wanted to see the harmonics to check up on the quality of the power supply. Or perhaps, as curious as I am, just wanting to see it.

The most frequent used equipment for measuring our 230Vac mains would be the multi-meter. Portable and inexpensive. Providing us the basic measurement for checking the wire voltage. The power is quite reliable in urban area, always maintain it's voltage reasonably at 230Vac. Probably a test pen can be the only measuring equipment you need.

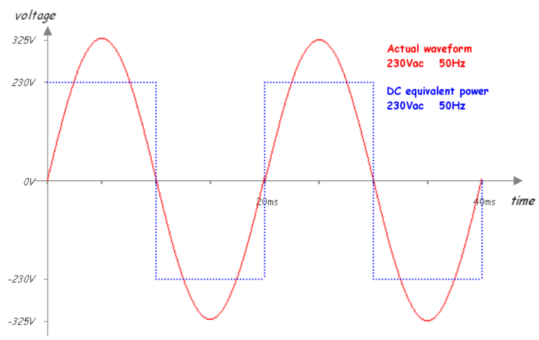
When we measure the ac mains from the socket using the digital multi-meter, we will get a reading of 230Vac or 110Vac (depending



graphic taken from:
http://www.allaboutcircuits.com/vol_1/chpt_3/9.html

The waveform of the AC mains 230Vac 50Hz is shown in red.

The signal we should see on the scope.... (click to enlarge)



on the country you are in). Take special note that this reading is effectively the rms (root mean square) voltage. The actual peak voltage of the electrical line go up to about 325Vpeak. The 325Vp (peak) sine wave is equal to 230Vrms.

$$Vrms = \sqrt{2} \text{ x } Vp.$$

$$230Vrms = 0.707 \text{ x } 325Vp.$$

Vrms can be think as the equivalent voltage in dc for power computation. The actual AC power (sine wave in red) has the same energy as one that is illustrated in the Vrms view point (square wave in blue). The energy can be computed, and they are defined as the area under the waveform. Area under the square & sine wave is equal. I have draw out the waveform to illustrate the idea.

Keep in mind the peak voltage. It would be useful in helping you select the proper component. Capacitor is one of such component where the capacitance and voltage rating is the main criteria for selection. Voltage higher than what the it can take, the capacitor will experience voltage breakdown. Pop, the capacitor can have a mini exposion.

So do remember, the AC mains is in fact 325Vp (peak) or 650Vp-p (peak to peak). That is very high voltage!!!

references:
http://en.wikipedia.org/wiki/Alternating_current

The Practical Part.........

Yes. Now that we get our theory clear, let's get on to the real hands on.

Date: 2009-08-01
This is one of the most exciting experiment that I ever done. Ever since my first disaster measuring AC mains, my understanding of oscilloscope and AV mains remains very unclear. Every step is carefully think of, carefully executed. This is unlike any other new electronics circuit that I want to experiment with. Any minor doubt that I have, I will research on the internet to confirm my understanding before I connect up the circuit.

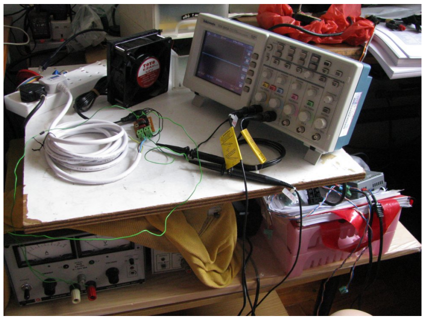
It feels to me like experimenting with dangerous explosive. One mistake, either my life at risk, or my expensive digital oscilloscope gets damaged. It is the most detailed experiment that I ever done.

For an experience engineer, this can be as easy as ABC. For a first timer like me who have never measure the 230Vac line, and no senior to guide me, this is really frightening yet exciting. I am sure we will have a better understanding of high ac voltage, with this step by step measurement guide. Dealing with 230Vac will eventually be as easy as ABC.

So let me starts this exciting experiment.

NOTE: Click on the image for a clearer view.

My measurement setup for measuring the output of the zero crossing triacs circuit. A [detail connection of this setup] is shown in the following section.

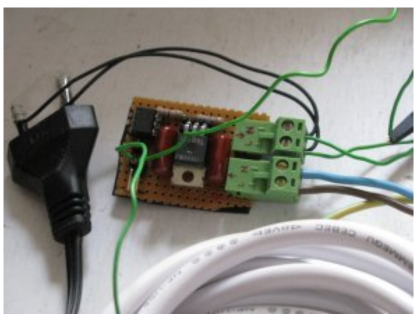


The picture on the left is the setup that I have prepare for the 230Vac signal measurement.

Equipment used in this measurement experiment

- 3 pin extension socket (protected by RCD device)
- Triacs switch circuit
- DC power supply (to activate the triacs circuit)
- AC fan (device to be controlled by the switch circuit)
- Oscilloscope (Tektronix TDS 2014) and probe.
- Some wires for connection.

My triacs switch circuit. This switch circuit is solid state relay. Just like a mechanical relay, the circuit interface helps digital control circuit to control a 110/230Vac mains devices. There is a AC input and the controlled output as shown by the green wire terminal. Click here for further detail information on this circuit on another page.



Probe ground crocodile clip is clip onto the oscilloscope Earth pin. The measurement for Live/Neutral signal is with reference to the Earth potential.

The circuit that I am going to measure is the output of a AC switch circuit presented on the left. The circuit using a triac component to switch the AC power. If you are interested to find out more about this circuit, you can visit the following page I have put up.

- about Triacs circuit

The following summaries the steps taken in order to do a proper measurement.

1) All the equipment for the experiment is powered from the RCD (residual current device) protected extension plug. This is to protect myself in case I accidentally touches the live/hot wire. The RCD will cut off the power in the case of power leakage through my body.

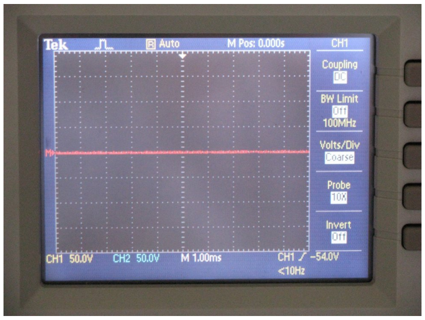
2) Connect up two probe from the oscilloscope to the circuit. CH1 probe is connected to the Live wire output, while CH2 is connected to the Neutral wire. The ground clip of the probe should be connected to the oscilloscope Earth pin. You should able to see such a pin on your scope with the Earth/Ground symbol (see the photo on the left). This is the setup for measurement with reference to the Earth ground. This Earth pin is internally connected to our 3pin AC socket. Therefore the pin is the same as our 3 pin plug Earth. The grounding clip from the oscilloscope is found to be Earth, so in fact there is no need to connect up. For clarity and safety reason, just connect it up. Always ensure that your oscilloscope is properly Earth for safety reason.

3) Set the probe attenuation to 10x. On probe there is a switch labeled 1x and 10x. 1x means that the probe signal is exactly feed into the scope. 10x means that the signal will be attenuated to a factor of 10 times before feeding into the scope. The scope may not be aware of the attenuation, so it is important to setup the scope for the 10x measurement. If this is not done, you will find that the reading is 10x smaller than expected. A 10V signal will be read as 1V. It is not important but will be clearer if you just set it on the scope. The signal is expected to see on the scope should be a 325V. After attenuating the probe, only 32.5V is actually feed into the oscilloscope input. Tektronix TDS 2014 oscilloscope can accept signal up to 300V. Without the attenuation, the scope might just blow up. Although the scope received only an input of 32.5Vp, it multiple the scale by a factor of 10 because of the settings I have done on the scope.

4) The reading is going to be very high, so set the voltage div for both CH1 & CH2 to the max. In my case after adjustment to the 10x factor on the scope, my max setting is 50 volt/div.

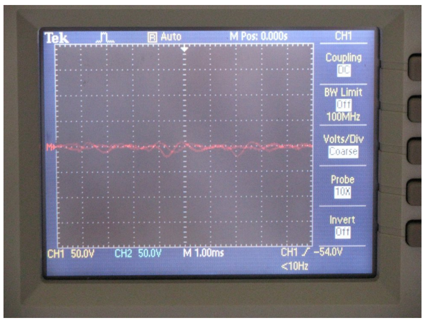
5) Set the scope to Math function: CH1 - CH2. CH1 is measuring the Live signal with reference to Earth while CH2 is measuring the Neutral wire with reference to Earth. In order to measure the signal Live with reference to Neutral, we need the scope to do some math, CH1 - CH2. (A red trace appear representing a new trace CH1 - CH2). Disable the CH1 & CH2 trace so that you can see only CH1 - CH2 trace clearly.

6) Ensure that all wire is properly screwed and secure. Pull individual wire, and ensure that it does not comes off.

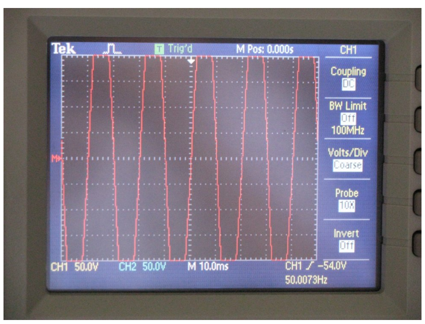


The oscilloscope presents the signal at the output of the triacs switch circuit.

The AC mains power is not switch on to the triacs switch circuit yet, so no signal is detected at the circuit output..



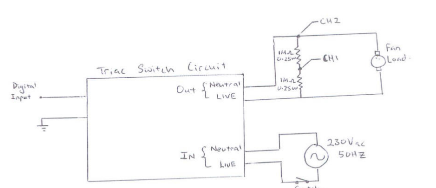
Once I switch on the mains switch, some small noise is detected at the output of the circuit. The triacs is in the off state but some signal is being observed. This means that there are some leakage. The leakage is ok because it is too small to activate the AC fan.



The triac switch is activated and the 230Vac is observed at the output. Yes, this is the 230Vac. But there is a problem. The voltage is too high for the oscilloscope to display. My scale is to 50 volt/div, and I have only 8 division on the y-axis for display. This means that I can only measure in the range of 200Vp-p. The reason for the signal clipping on the display.

To display the full 230Vac range or 325Vp-p. We need to attenuate the signal more. Some probe you have the option to attenuate by 100x.

230Vac measurement connection with oscilloscope

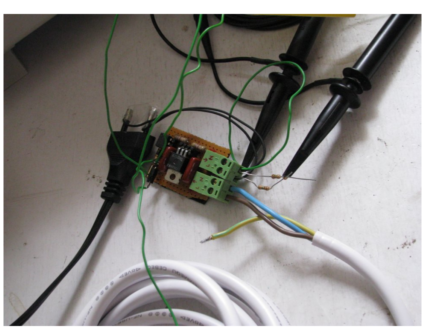


My probe only allows me to attenuate the signal by a factor of 10. I will need to attenuate the signal further.

For my case, I have a voltage divider using 2x 1MΩ (0.25W), to attenuate the signal by two times before feeding the signal to the probe. The voltage divider is connected across the output terminal of the Live and the Neutral wire. CH1 is connected to the divided voltage (between the two resistor), while the CH2 remains connected to the Neutral wire.

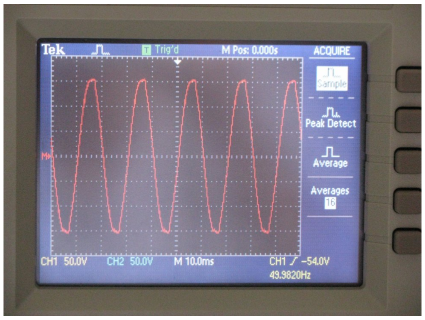
You can use other resistor value but you need to ensure that the resistor wattage is able to handle the high voltage. The maximum voltage across the Live/Neutral is 325V. If 2x 1MΩ is used for he voltage dividing, the maximum current expected will be about 0.16mA. The minimum wattage required is therefore 325V x 0.16mA = 0.053W. I have used a 0.25W resistor, which is more than enough. If you are using 2x 10kΩ resistor divider, make sure your resistor wattage is at least 6W. There will be more current flowing through the resistor, more energy dissipating across it, and it is going to be hot. A lot of energy is wasted if you use lower resistance.

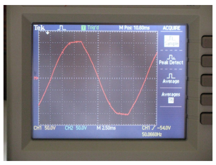
Measurement with voltage divider across Live & Neutral wire.



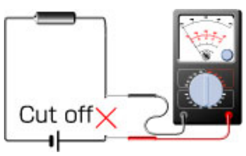
The left present the actual measurement setup with a voltage divider circuit to attenuate the signal so that the oscilloscope is able to display the high voltage.

Remember to multiply the voltage by 2 times while you analyze this waveform. This is because the voltage has been divided by 2 due to the voltage dividing circuit. Click on the photo to enlarge the signal 650Vp-p at 50Hz, representing our 230Vac mains supply.

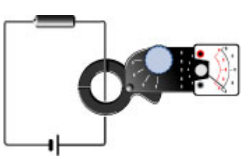




Measuring current by inserting the meter into the current path.



Measuring the AC current using the clamp meter. Easy, just clamp it.



picture taken from:
http://www.nakano-permalloy.co.jp/e_clamp_on_meter.html
http://www.licensedelectrician.com/Store/AM/AC71B.htm

Finally a clear 230Vac waveform display with a period of 20ms. I finally managed to measure the 230V mains.

On the scope, the signal display about 320Vp-p, but in fact the signal is actually about 640Vp-p. This is because of the voltage divider that I have added and the scope just have no idea about it. So mentally, you need to multiply by 2 to get the correct reading. This is about the same as what we have computed previously. 230Vrms has the actual waveform of 650Vp-p at 50Hz. Any capacitance component attached across the Live & Neutral wire have to withstand at least the voltage of 325V. This is important for our component selection.

After this write up I have better confidents in dealing with 230Vac and it's electronics. Something that I often used and understood little about it.

It is so interesting. If only I am as curious when I am in school during my teenage days. There would be many teachers to guide me in the understanding. As a teenagers, most of us probably be fooling around rather than learning seriously and actively. Wanting to learn and know more than what the lecturer teaches.

I hope you have enjoy, and get a better understand in dealing with 230Vac measurement.

Measuring Current

How much current is being drawn from your wall socket. You might probably want to know how much energy your equipment/appliances is consuming.

For measurement of current, a cable clamp meter is recommended. Clamp measurement detects the invisible alternating electrical field generated by the 230V ac 50Hz. No contact with the copper wire, just clamp around the cable. This is all about Faraday Law, founder Michael Faraday. It is actually very interesting learning about the history of how people actually discover these physics. They are great people. I watched a very interesting science history documentary. A documentary about the history and concept behind $E=mc^2$. I think it would be great to share you everyone.

Do a search on,

"E=mc2 - Einstein and the World's Most Famous Equation"

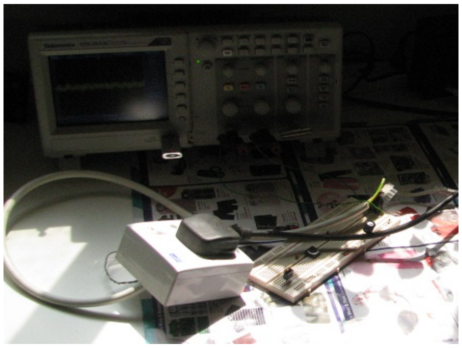
Measuring Current using a current sense coil or transformer

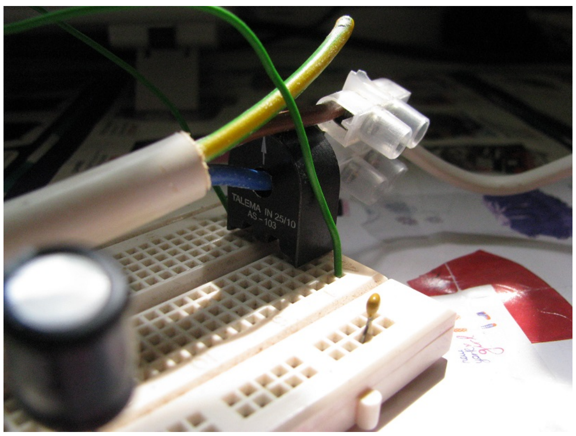
The picture on the left is a mini current transformer. To measure the current flowing through your AC power line, either a "Live" or

a mini current sensor for AC power line. Comes with 1:300, 1: 500, etc... transformer coil ratio

"Neutral" wire has to be put through the hole located in the centre of the sensor.

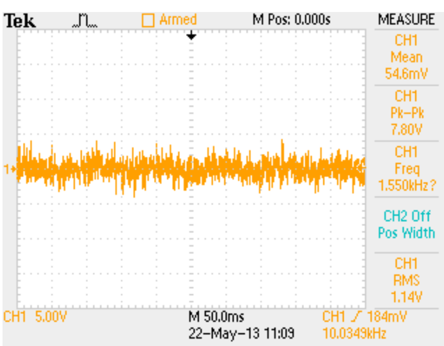
The sensor consist of fine wire coil inside. The coil is wind around the circular core, forming a ring to sense the AC magnetic field around the AC power cable through the hole. It is important that only the "Live" or "Neutral" wire can be inserted through the hole. If both the "Live"and "Neutral" are put through the hole, the signal will be minimum. This is because the magnetic field of the out going wire will be cancel off by the returning wire.



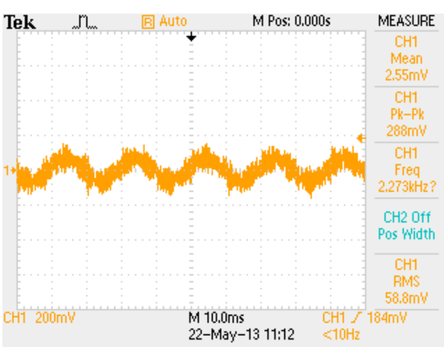


The picture on the left is a simple setup with the oscilloscope probe to the two terminal on the current sensor.

Note that only 1 wire (Neutral) through the hole on the current sensor.



Signal at the output of a 1:300 coil transformer, while powering up a sprindle motor. The motor load is an inductive load. The current signal being pick up is quite noisy from the motor. The signal is about 5Vp-p.

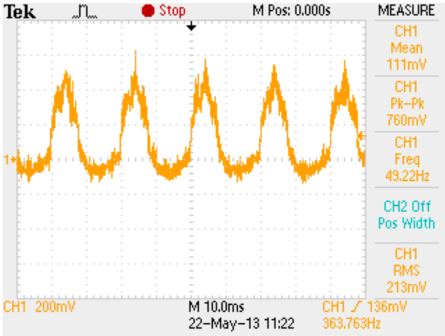


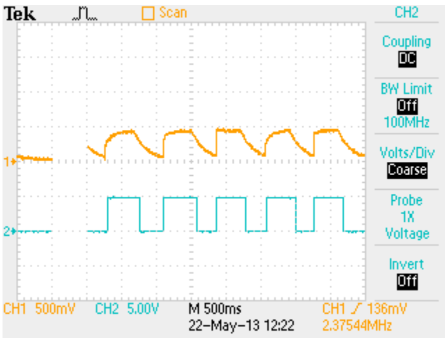
Signal at the output of a 1:300 coil transformer, while powering up a soldering iron. The soldering iron is a heating element which is a resistive load. The current signal looks like the 230Vac 50Hz sin wave at about 0.2Vp-p.

This is a rectified signal (using diode bridge) picked from the sensor. The power line is not powered up, no load. I thought it should be

flat. It could be noise generated from other nearby appliance through the "Neutral" wire.

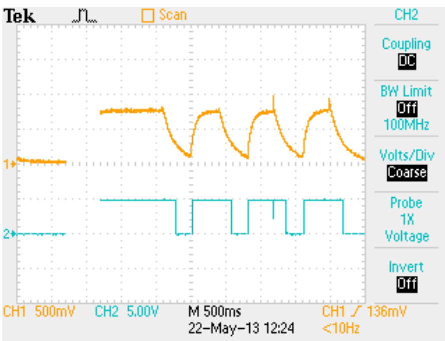
The signal seems weird, but I did not investigate much on this result.





Ch1 is the rectified signal picked up by a 1:300 current sensor. The motor load is being switched on and off.

Ch2 is the signal conditioned through a LPF (low pass filter) and an op-amp comparator circuit. A clean result showing the motor being on and off.



Ch1 is the rectified signal picked up by a 1:500 current sensor. The motor load is being switched on and off. As you can see, the magnitude of the signal being picked up is higher. A higher voltage output, is being trade-off with a lower current drive. Since the signal will be conditioned by an op-amp, having a low current drive is not much of a problem.

Ch2 is the signal conditioned through a LPF (low pass filter) and an op-amp comparator circuit. A clean result showing the motor being on and off.

Computing Appliances Electricity Usage

Now that we measured the current consumption, I am starting to be curious on the power consumption for a typical home. Just for the fun of it, I have investigate some of the high power consumption appliances.

Energy (Wattage) = Voltage (Vrms) x Current (Ampere)

reference:
http://michaelbluejay.com/electricity/computers.html

Energy meter to measure power consumption of your electrical appliances.

How much does my power cost?

SINGAPORE POWER

Energy cost: **S$0.1803/kWh** as on 16 Jun 2009

Energy cost: **S$0.2558/kWh** as on 1st Apr 2011

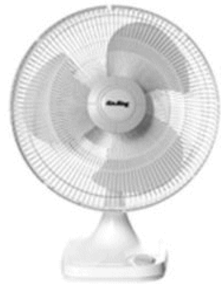
Energy cost: **S$0.2728/kWh** as on 1st July 2011

This means that it cost S$0.1803 running an appliance consumption 1kW for an hour.

See more energy measurement at another webpage Energy Audit

Air King Model 9106

Energy: **57-77Watt**



Energy consumption for 8hr/day= 77W x 8hr = 616Wh

Energy consumption for 30 days = 616Wh x 30 = 18.48kWh

Energy cost for 30 days = 18.48kWh x $0.1803/kWh = **$3.33**

Energy for a Fan will cost about $2.47-$3.33 per month

Daikin Inverter Multi Split (R-22)

Energy: **1520-6900Watt**

Energy consumption for 8hr/day= 6900W x 8hr = 55.2kWh

Energy consumption for 30 days = 55.2kWh x 30 = 1656kWh

Energy cost for 30 days = 1656kWh x $0.1803/kWh = **$298.58**

Energy for a Fan will cost about $65.77-$298.58 per month

MSZ-FB series

Energy: **2500-5000Watt**

MR-560U 560 litre Refrigerator

Energy: 570kWh/year
or 65W when I divide that number with 365 days x 24 hours

Energy consumption for 8hr/day= 65W x 8hr = 520Wh

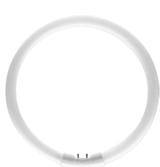
Energy consumption for 30 days = 520Wh x 30 = 15.6kWh

Energy cost for 30 days = 15.6kWh x $0.1803/kWh = **$2.81**

Energy for a Refrigerator will cost about $2.81 per month

Philips MASTER TL5 circular fluorescent lamp

Energy: **22-60W**



Energy consumption for 8hr/day= 60W x 8hr = 480Wh

Energy consumption for 30 days = 480Wh x 30 = 14.4kWh

Energy cost for 30 days = 14.4kWh x $0.1803/kWh = **$2.60**

Energy for a fluorescent lamp will cost about $0.95-$2.60 per month

Philips PL-T compact fluorescent bulb

CFL, compact fluorescent

Energy: **32-42W**

Energy consumption for 8hr/day= 42W x 8hr = 336Wh

Energy consumption for 30 days = 336Wh x 30 = 10.08kWh

Energy cost for 30 days = 10.08kWh x $0.1803/kWh = **$1.82**

Energy for a fluorescent lamp will cost about $1.38-$1.82 per month

Incandescent Light Bulb

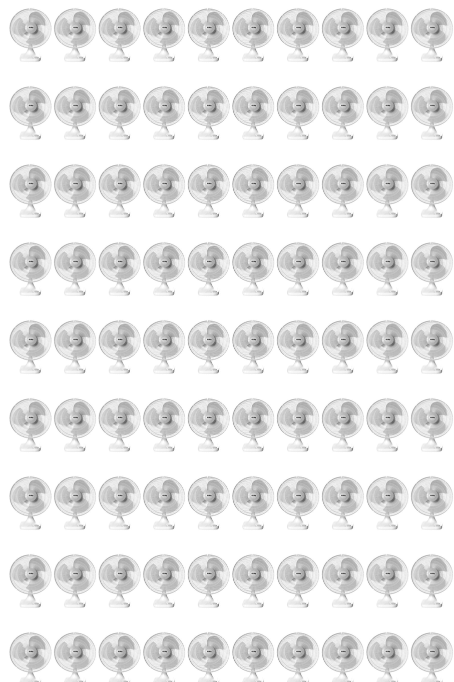
Energy: **50W**

Incandescent seems to have similar wattage with the fluorescent. In fact a 15W compact fluorescent can have the equivalent brightness of the 50-60W incandescent bulb. Therefore using fluorescent can be cost saving.

http://www.caus.vt.edu/maketheswitch/pages/facts.html

The energy cost matches quite well with my home monthly electrical bill. I am quite surprise that the fridge use so much less energy. Did I make any wrong assumption? Now I also aware that the energy to turn on the aircon for a day, is enough to operate a fan for 3 months.

=



End of the fun. Let us start to research more about the AC ingredients available.

See more energy measurement at another webpage Energy Audit

3. Working with 230Vac electronics

Component suitable for switching on and off 230Vac devices.

- Mechanical relay
- Solid state relay
- Triacs
- Thyristor
- Capacitor (high voltage rating)
- Resistor (high wattage rating)
- Transformer

about transformer- transformer.pdf
reference from http://www.melcontransformers.info/

The list on the left are namely some of the common components used for controlling 230Vac appliances.

This section is closely related to switching. So I decide to divert your attention to the switch. The range of components for controlling your appliances. It is all about

"Switch"...

So let's move on to learn more about switch.

AC to DC conversion (Transformerless)

Our electrical system uses high AC voltage to distribute energy to our homes. Most gadgets works with DC voltage, therefore we often see a AC-DC circuit module as part of the gadget.

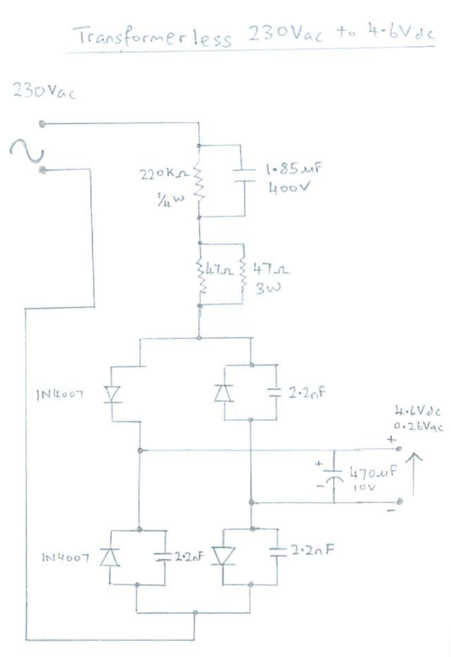
Some AC-DC module are integrated into the product; for example, our computer, DVD player, radio. Some AC-DC module comes in the form of power adaptor that supply DC voltage to the devices.

The AC-DC module is so common, it will be useful to learn about them. Most AC-DC contains a transformer to isolate the DC voltage from the AC mains. This acts as a form of protection, so that people will not get electrocuted when touching the DC circuit.

There is also a newer type of AC-DC using switching method. It is something similar to switching DC-DC method. The transformer used can be alot smaller. You can see that old power adaptor was heavy and bulky. The power adaptor nowsaday are light and small.

Another type of AC-DC module uses only resistors and capacitors, without any transformer. They are also known as transformerless AC-DC circuit. You need to be careful when handling this type of cicuit as it is not isolated from the AC mains. You will get electrocuted touching the DC circuits. Please refer to the section above to understand more about 230Vac and how one can get electrocuted. Transformerless circuit is simple and cheap, and it is suitable for application that consume low power.

Example: Transformerless 230Vac to 4.6Vdc

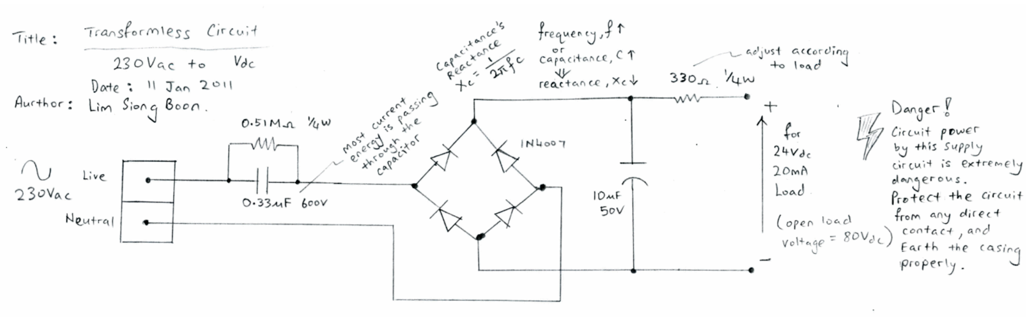


This circuit converts 230Vac to 4.6Vdc without using any transformer. Please take note that the circuit is not isolated from the 230Vac mains; ensure that the circuit is enclosed and properly earthed to prevent accidental electrical shock.

(Last update: 31 Oct 2010)

[Please click here to see the transformerless AC-DC circuit schematic.]

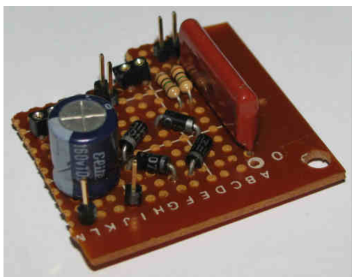
Example: Transformerless 230Vac to Vdc (for a load of 24Vdc 20mA)

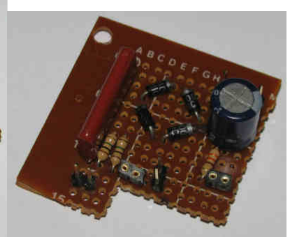


This circuit converts 230Vac to Vdc suitable for a 24V 20mA load, without using any transformer. Please take note that the circuit is not isolated from the 230Vac mains; ensure that the circuit is enclosed and properly earthed to prevent accidental electrical shock.

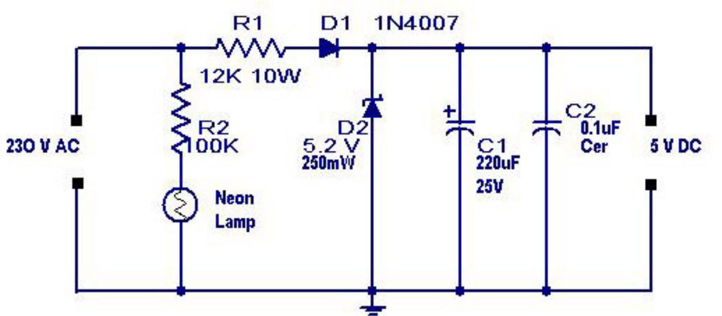
(Last update: 12 Jan 2011)

[Please click here to see the transformerless AC-DC circuit schematic.]





Another transformerless circuit 230Vac to 5Vdc that I found on the internet. (I have not tested this yet)



AC-DC integrated circuit product manufacturer

You can refer to the datasheet on their website for the datasheet and application notes.

High efficient ac-dc conversion IC

- isolated (smaller transformer component)

- non isolated (transformerless), LNK306DN

- isolated (smaller transformer component), VIPer12A

AC-DC switching IC
IC: LM5021
IC: IRIS4013(K), IRIS40 series, irismps3.pdf
IC: NCP1200, AND8023-D.PDF
IC: NCP1215, AND8128-D.PDF
IC: NCP1271, AND8242-D.PDF
IC: NCP1381
IC: NCP1603, AND8207-D.PDF

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4. AC lightings wiring guide

Keyword: difference between normal fluorescent, PLC lamp
LEd fluorescent circuit
power supply LEd fluorescent circuit

Connecting electronic ballast with a fluorescent lamp.

http://www.goodmart.com/facts/light_bulbs/ballast_wiring.aspx
http://www.repairfaq.org/sam/flamp.htm
http://en.wikipedia.org/wiki/Ballast_(electrical)
http://www.oksolar.com/lighting/ballasts.htm

EXAMPLE

Say hob 32a
Say oven 32a

Total load 64amp

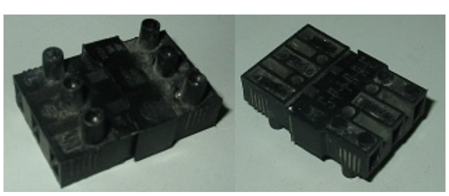
Cooker apply diversity

1st 10a 10amp
30% of 54a 16.2amp
Allow for socket 5amp

Ib 31.2amp
(Ib no socket 26.2amp)

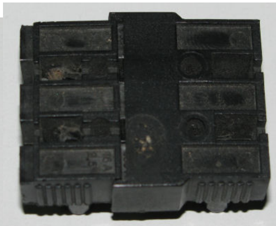
Pluggable connector for 230Vac lighting points (Live, Neutral, Earth)

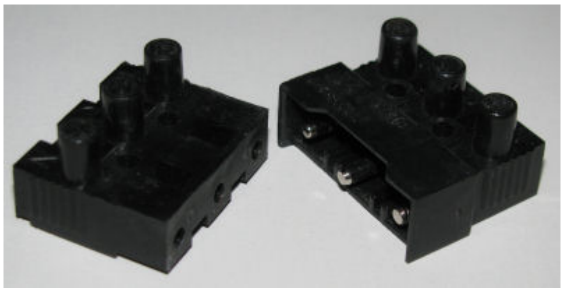
SPINNE EM16 connector (Black)



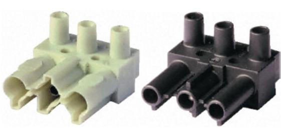
163 3 TS IEC998-2-1 connector (Black)

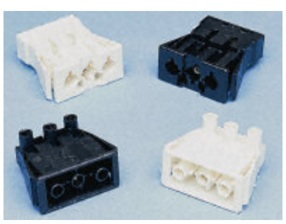
Pluggable 3 way connectors from wieland, commonly used for connecting electrical AC cables to lightings lamp. The connector can be pre-installed onto the power termination point and the mating connector on the lamp component. This simplifies the cable to lamp connection and allows faster installation.



Can be purchased from New Starlight Industries Pte Ltd
http://www.newstarlight.com/prdt76.html




quick release connector (no need to screw on the wire)

5. Ground Loop

references:
http://sound.westhost.com/earthing.htm
http://www.compliance-club.com/archive/old_archive/020918.htm

Keyword: Vac mains, 230Vac 110Vac, High Voltage, Electrocute, Danger

Wall sockets, power points, power sockets, electric receptacles, electrical outlets

email: mail@siongboon.com
website: http://www.siongboon.com

Pb battery status indicator
Acid accumulator condition indicator

The indicator is used to determine the status of the lead accumulator. I used it in a backup source with a maintenance-free gel lead accumulator. It can also be used in a motor vehicle to indicate battery status and recharging, similar to the once popular "Batest".

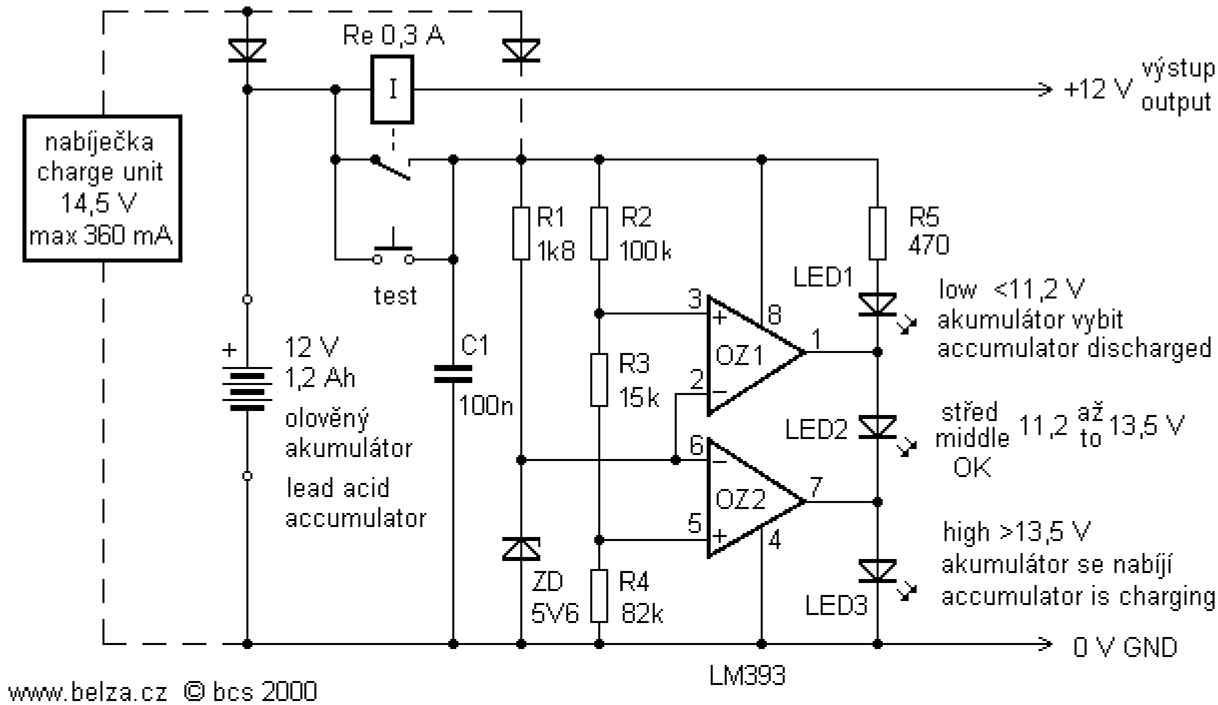


Fig. 1. Pb battery status indicator
Fig. 1. Acid accumulator condition indicator

Description involvement

In the indicator (**figure 1**) a double comparator with open collector LM393 is used. The supply voltage reduced by the R2, R3 and R4 dividers is compared with the voltage of the Zener diode. The device will distinguish three voltage levels. With these components, these voltages are up to 11.2 V (LED1 lit), 11.2 to 13.5 V (LED1 and LED2 lit) and voltages greater than 13.5 V (all LEDs on). For other voltages, the resistors of the divider must be changed or the Zener diode replaced. Gently adjust the indication range by changing the current flowing through the Zener diode, ie by replacing the R1.

I used the indicator in conjunction with a maintenance-free battery and a switched source in a 12 V power source to power the radio and the old video camera. The indicator turns on automatically when the current is being drained. A current relay is used for this, see **Figure 2**. The current relay should be made by winding approximately 120 threads with a 0.38 mm diameter wire to contact the reed relay. Then the relay switches to about 300 mA at the current. The resistance of the coil in my case was about 0.3 Ohms. For larger streams, we will draw less wires with a thicker wire. If, on the other hand, we have a larger number of threads with a thinner wire, we attach two steel washers to the contact of the relay (the tube) between which the wire is wound up. Thread the winding with a shrink sleeve. You can also turn on the test button at any time. To indicate the voltage of the onboard network in the car, the relay does not need a button, the indicator is switched to the point where the voltage appears after turning the starter key.

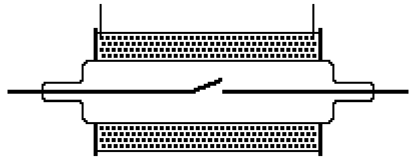


Fig. 2. Current relay
Fig. 2. Current relais

You can put the indicator on the printed circuit board according to Fig. 3. It is best for it to be energized from the regulated power supply. We set the voltage at 11 to 11.5 volts at the source. The green LED should be lit within the voltage range. The yellow LED should light up in the range of 13 to 13.8 V. If this is not the case and the comparators are tilting at a lower voltage, the reference voltage is small. Without D1, we can help to reduce resistance of resistor R1. If the comparators are tilting at higher voltages, we increase R1. For larger deviations, you need to exchange ZD.

Inside the car, we place the indicator on the dashboard of the car in the driver's field of view. Connect the 0 V (-) lead to the ground, the 12 V (+) terminal, eg to the outlet of some fuse on which the voltage is ON only when the ignition is switched on. Then the tester will be automatically turned on only when driving. Contact the relay in this case with a jumper.

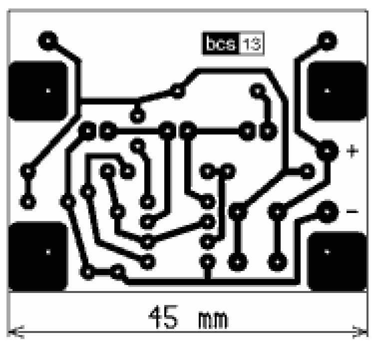


Fig. 3. The printed circuit board of the voltage indicator. Click to get a picture at 600 dpi
Fig. 3. PCB layout indicator. Click to get 600 dpi resolution image

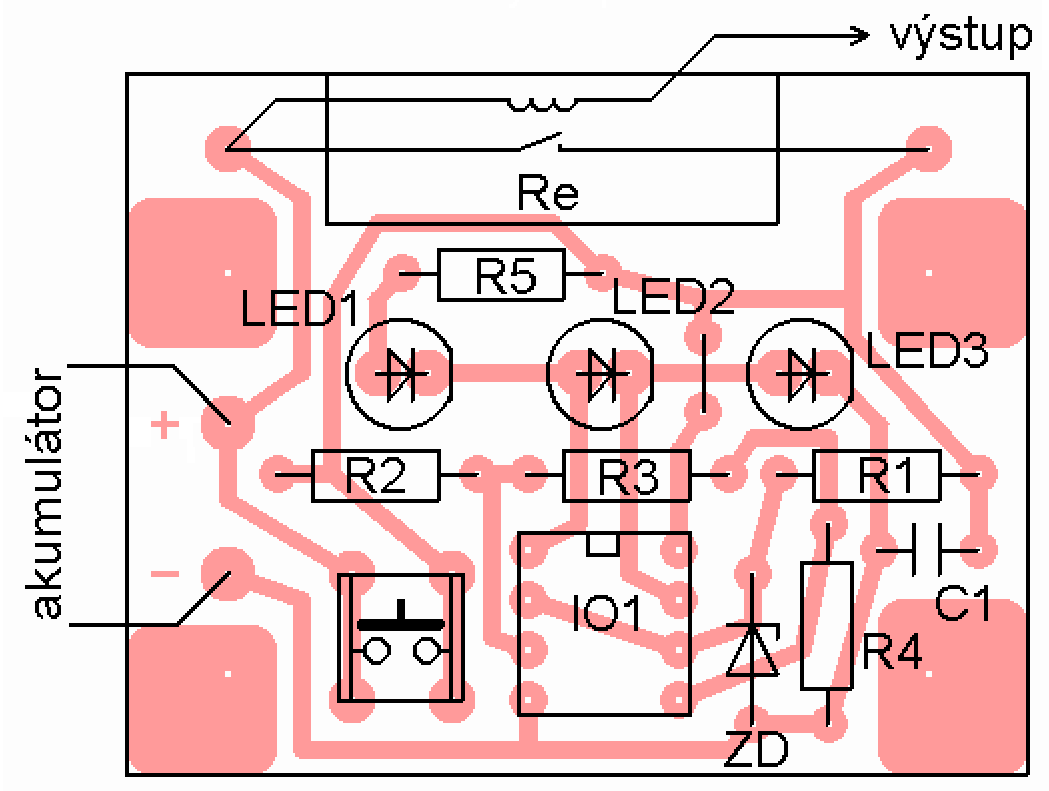


Fig. 4. Layout of the components on the board
Fig. 4. Locations of components on the board

Fig. 5. Indicator plate
Fig. 5. Indicator board

Parts list

R1	1.8 kOhm
R2	100 kOhm

R3	15 kOhm
R4	82 kOhm
R5	470 Ohm
NO. 1	100 nF, ceramic.
LED1	red / red
LED2	green / green
LED3	yellow / yelow
ZD	5,6 V (BZX83V005.6)
IO1	LM393
Re	current relay / current relais
Tl	button
Circuit board	bcs13

Jaroslav Belza

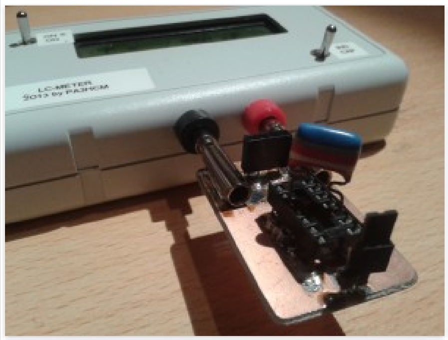
Practical Electronics 7/1996 p. 30 (under pseudonym VH)
Structural Electronics 3/1997 p. 94

25. 7. 2000

Ernest Neijenhuis Homepage
PA3HCM

Adapter for LC meter

Posted on 15 September 2014 by Ernest



The LC meter adapter in action.

The dutch electronics shop Van Dijken Elektronica sells a nice kit to build your own LC meter. The kit includes a professional PCB, all components, building instructions, prepared case and leads. The kit takes an evening to assemble, the result is an instrument to measure capacitors and inductors. Every radio amateur should have one.

I bought and built this kit about two years ago and used it with almost any homebrew project. But every time I had some trouble with the leads. Moving them results in a different distance between the leads and influences the measurement. Tonight I decided to get rid of the leads and build a simple adapter. It took me an hour to build, and another 30 minutes to write this article.

The adapter is made of copper clad. I cut the copper in the middle and soldered a 4mm connector on each side of the gutter. I soldered an IC socket and a 2-pin jumper, both above the gutter. The jumper makes it easy to shorten the adapter (required for callibration when measuring inductances). Just look at the pictures down here and I'm sure you can build your own adapter. Just modify the connectors (probably just the spacing) to use the same idea on any other LC meter.

How to measure an inductor using this adapter:

- Connect the adapter to the LC meter.
- Be sure no components are placed on the adapter.
- Place the jumper.
- Power on the LC meter in L mode.
- Remove the jumper when the 'Callibrating' message disappears.
- Place the inductor in the IC socket and read its value from the display.

Measuring a capacitor is about the same, except that the jumper needs to be removed before powering the LC meter.

The LC meter with the original leads.

The same LC meter, now with my adapter.

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search...

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→ 30m QRP transceiver: part 1, 2, 3, 4, 5, 6
→ HB9CV-in-a-box antenna for 23cm
→ Automatic antenna tuner using an Arduino
→ Squalo antenna for 6m
→ Pixie2 QRP transceiver for 80m

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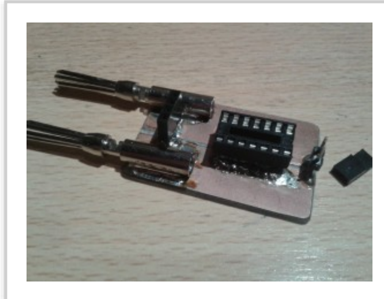
January 2015 (1)

LC meter adapter, front view.



LC meter adapter, side view.

Posted in Tools and measurement | Tagged adapter, beginners, lc-meter, manhattan-style | Leave a reply

← Altoids L-tuner

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Important notice

This is my personal website, it reflects my personal opinion and has no relation to my job or whatsoever.
An appropriate amateur radio license is required to own and/or build and/or use the transmitters described on this website, depending on local regulations.

Ernest Neijenhuis Homepage
PA3HCM

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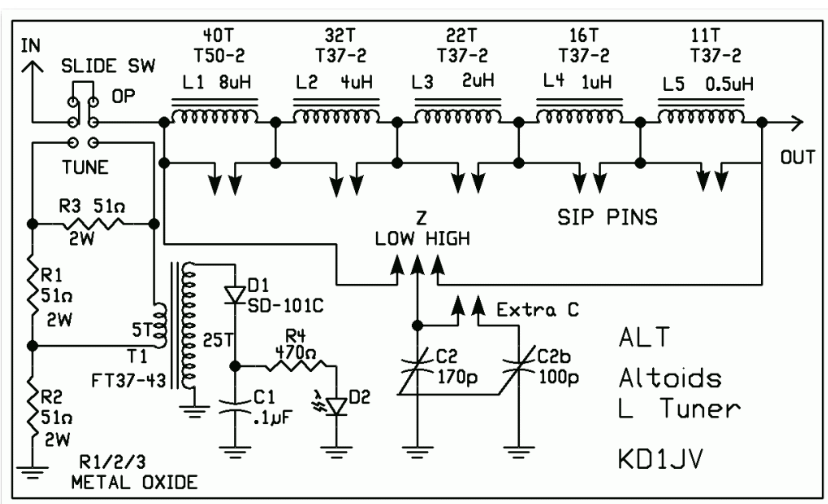
Altoids L-tuner

Posted on 25 August 2014 by Ernest

A while ago Tjeerd PA3GNZ donated me some Barkleys mint tins (identical to the famous Altoids tins), which are rather popular by QRP builders to house small homebrew stuff. Two weeks later I found a czech webshop, offering a kit called "Altoids L-tuner". This kit perfectly fits in such a tin. Since this tuner would be a perfect add-on for my 30m QRP transceiver, I immediately ordered it.

My Altoids L Tuner

The kit is a reproduction of a design made by Steve Weber KD1JV. Steve named it the "Altoids Long Wire Tuner". It is meant to tune long wire antennas for 10-40m. The design is a L-match (series inductor, parallel capacitor), it consists of 5 series connected inductors, followed by a variable capacitor to ground. By means of jumpers you can bypass individual inductors and thus select the desired inductance. The circuit also includes a poor man's SWR bridge, which can be enabled by a switch. The SWR is indicated by a LED.



Original circuit diagram of the Altoids Long Wire Tuner, by Steve KD1JV.

After about a month the package got finally delivered, probably delayed by the fact that I ordered the kit just a week before the yearly hamradio fest in Friedrichshafen. The kit consists of a high grade circuit board and all required components. No documentation was included, so I returned to the website and downloaded the documentation. This documentation is very poor, just one page showing the circuit and PCB layout. At the bottom of the page some URL's are given, including a website that links to this PDF-document. This document is a comprehensive building instruction for this kit, telling you how to wind the different inductors and where to place all components.

Once found the instruction it was very easy to build the tuner. I encountered two small issues:

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search...

Popular

→ 5/8 Wave vertical antennas for HF
→ 30m QRP transceiver: part 1, 2, 3, 4, 5, 6
→ HB9CV-in-a-box antenna for 23cm
→ Automatic antenna tuner using an Arduino
→ Squalo antenna for 6m
→ Pixie2 QRP transceiver for 80m

Tags

2m 3d-printing 6m 10m 15m 17m 20m 23cm 30m 40-30 40m 70cm 80m 160m antenna aprs arduino atv ax25 balun beginners clog contest cw digimode kenwood kit linux manhattan-style movie nails pacc pic qrp raspberrypi receiver repair result satellite straight key transceiver transmitter tuner vertical yagi

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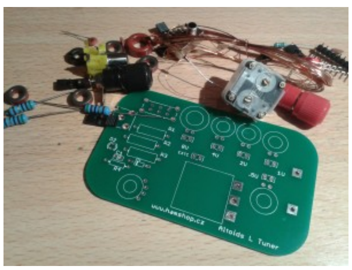
- The switch didn't fit, the PCB holes were to small, so I soldered the switch on top of it.
- The variable capacitor leads were too short, so I used small pieces of wire to connect it.

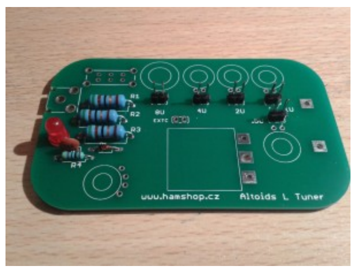
Altoids L tuner, lid closed.

I used superglue to fixate the capacitor and all inductors. I drilled a hole in each corner of the board and used bolts an nuts to place it into the tin. Between the board and the bottom of the tin I placed a plastic sheet to ensure isolation. I skipped the included onboard cinch connector and screw terminals, grabbed two screwtype cinch connectors instead from my junkbox, drilled holes in the case and placed the connectors. With some small wires I connected them to the board.

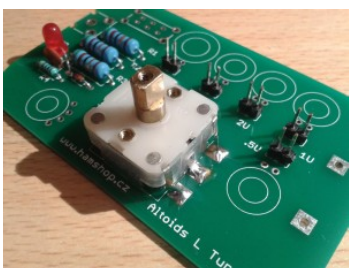
The tuner seemed to be ready now, however I could not close the lid. This was caused by the capacitor, the axis was too long. I cut away most of it. I browsed my almost endlessly filled junkbox again and found a small knob which fits at the remaining part of the capacitor's axis.



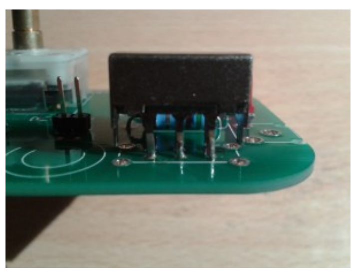
The kit contents.



Basic components placed on the board.



Capacitor in place.



The switch didn't fit due to too small PCB holes.

The prepared tin with bolts already in place. Note the small rings to maintain distance between board and bottom, and the isolating plastic sheet.

The board and connectors are placed in the tin.

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Important notice

- DKARS Magazine, September 2014

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← 30m QRP transceiver – Part 5 Adapter for LC meter →

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Simple
AM receiver with 4049 AM receiver with 4049 circuit

The CMOS 4049 circuitry, which works as an analog amplifier, is used in the receiver. Even though the receiver quite surprised me, do not expect any miracles from this simple engagement.

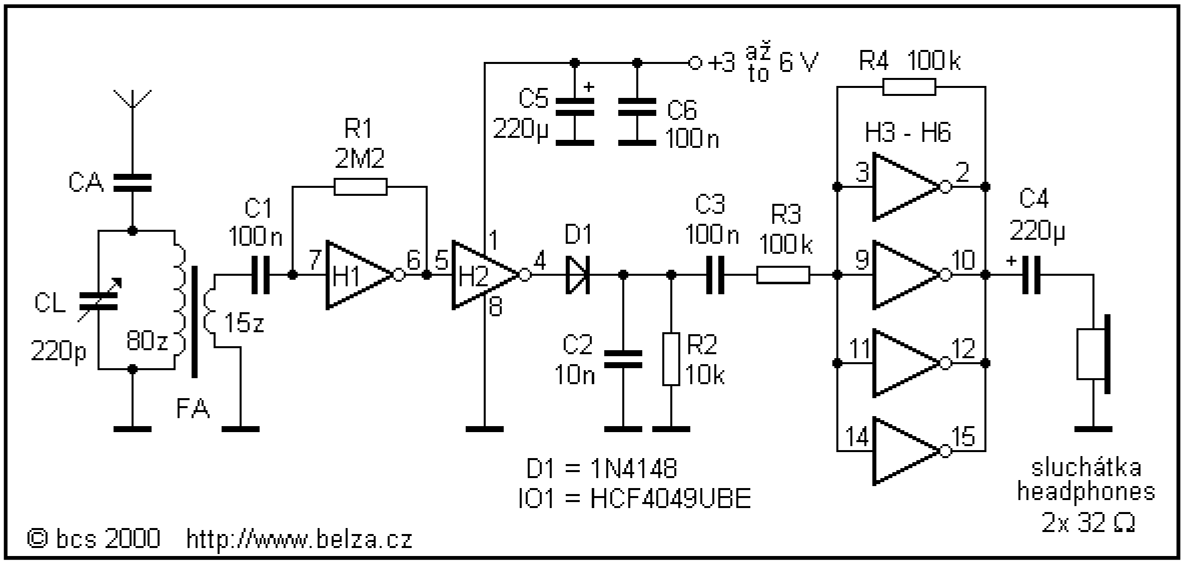


Fig. 1. Connecting the Receiver to the 4049 Circuit Board
Figure 1. AM receiver with 4049

Description involvement

The ferrite antenna signal goes through the capacitor C1 to the amplifier from the H1 and H2 inverters (the numbering does not match the order in the housing). The operating point is set in the "analog" region by the resistor R1 in the feedback of the first inverter. The operating point of the second inverter does not need to be set. Since without the signal at the output H1 the same voltage as the input, this voltage is also at the input H2. The characteristics of the inverters in one case are practically the same. In this amplifier, the entire voltage gain of the receiver is concentrated.

Following is a demodulator (rectifier) with diode D1 and a filter element R2, C2. If the volume controller should be used, connect the potentiometer instead of R2 and connect the C3 capacitor to the runner.

The demodulator is still an end amplifier. For listening, I used the usual "low-ohm" headphones that are supplied for example to walkman. For silent listening, a speaker with 50 ohm impedance can also be connected to the headphones. With a 8-ohm speaker, the receiver plays very quietly. The volume can be increased by using an output transformer that is connected between the receiver output and the speaker. Do not use very small speakers, have poor sensitivity. Because CMOS circuits are able to supply only a small current, all remaining inverters are connected in parallel. The end amplifier has a gain less than 1 (more precisely -1) without load load, set by resistors R3 and R4 in feedback. With earphones, the end stage gain is about 0.2 and the feedback is low. Resistor R4 is required to set the operating point, R3 would theoretically replace short-circuit.

For the sample, the optimal supply voltage was 4.5 to 6 volts, even though it ran from 3 to 9 volts. The receiver is very dependent on the supply voltage.

Tab. 1. Current consumption of the receiver depending on the supply voltage
Table 1. Power supply current vs. supply voltage

Udd [V]	3	4	5	6	7	9
Is [mA]	0.5	4.5	10	18	27	60

For the receiver I designed a printed circuit board according to Figures 2 and 3. The biggest problem will probably be the manufacture of the input tuned circuit. I used a ferrite antenna and a tuning capacitor from an old radio. On the ferrite antenna in Prague I captured ČRo2 station, with a short wire antenna (2 m) still Free Europe and Country radio. We only use the CA capacitor for a long antenna. The longer the antenna will be, the smaller capacity we use (50 to 1 pF). For a short antenna we will replace it with a short circuit.

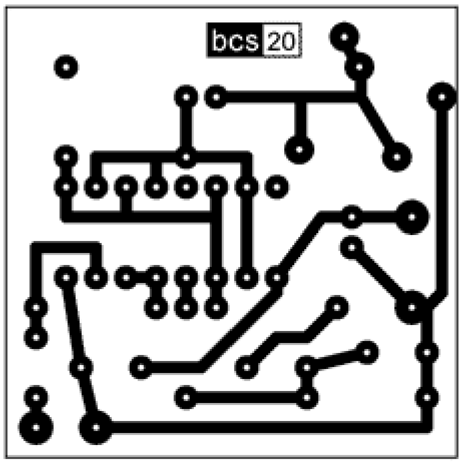


Fig. 2. Printed circuit board of the receiver. Click to get a picture at 600 dpi
Figure 3. Receiver PCB layout. Click to get 600 dpi resolution image

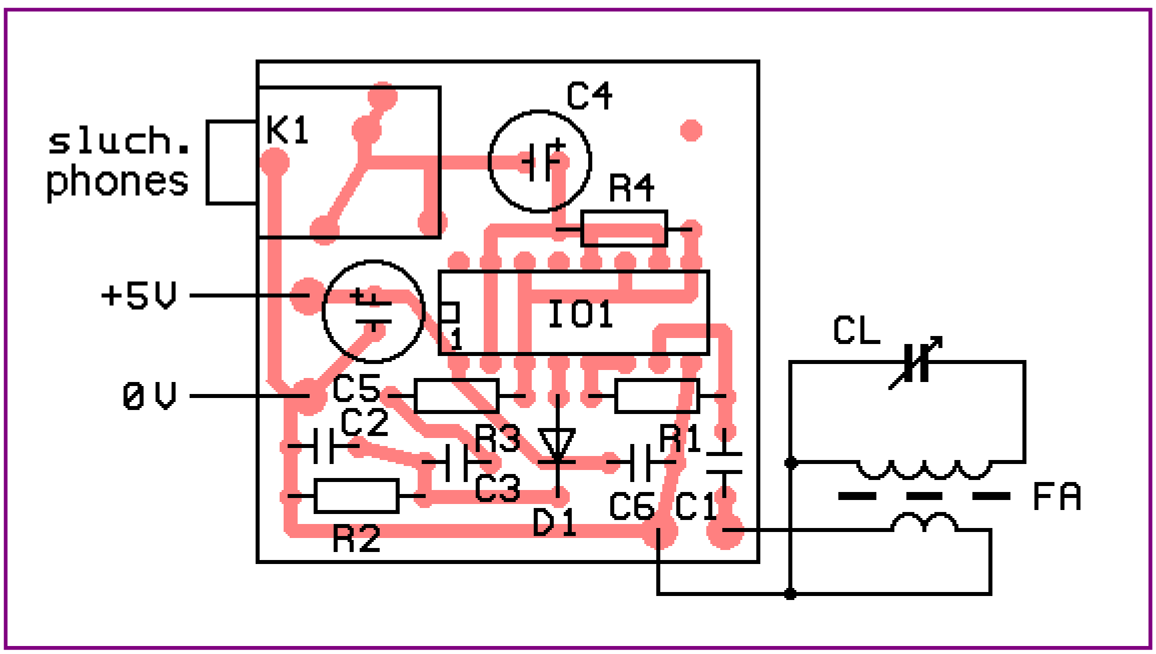
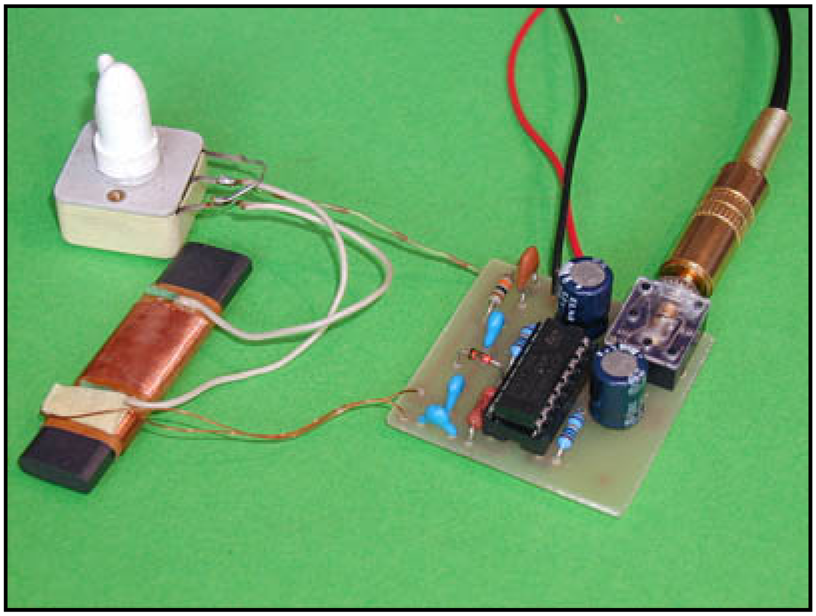


Fig. 3. Layout of components on the board
Figure 3. Locations of components on the board



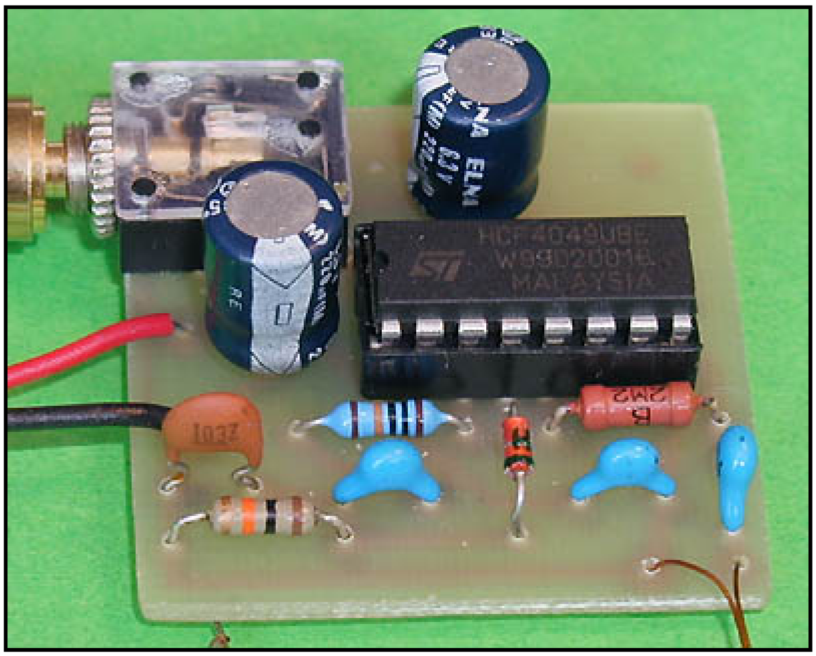


Fig. 4 and 5. Assembled receiver samples
Figure 4 and 5. AM receiver photos

List of parts

R1	2.2 MOhm
R2	10 kOhm
R3, R4	100 kOhm
C1, C3, C6	100 nF, ceramic.
C2	10 nF, ceramic.
C4, C5	220 µF / 6.3 V
D1	1N4148 (KA206, KA262, ...)
IO1	HCF4049UBE
FA	L1: 80-100 of L2: 10-20 z

CL	220 pF (150 + 64 pF)
CA	0 - 100 pF
K1	3.5mm jack SCJ-0354-U (SCJ-0354-5PU)
headphones / phones	2x 32 Ohm or output transformer and speaker optional: output transformer and speaker
Circuit board	bcs20

Jaroslav Belza

The article was published in Practical Electronics No. 11/2000 at p. 3 under the VH brand. Then here and here .

5. 11. 2000
22. 4. 2003 upd.

Analog Electronics

Your reference guide to analog electronics for your electronics projects.

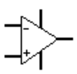
Edited by Lim Siong Boon, last dated 06-Jul-08.

email: mail@siongboon.com
website: http://www.siongboon.com

Short cut to your reference guides and charts

1. Op-amp
2. Capacitor for Signal Filtering
3. Transistor Switching

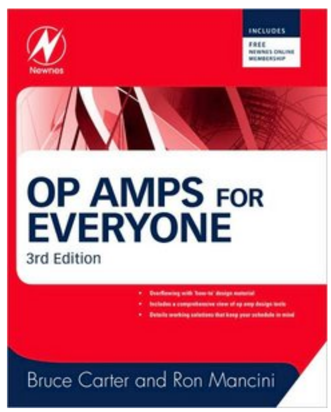
Op-amp



Op Amps for Everyone, by Bruce Carter and Ron Mancini from Texas Instruments.

op amps for everyone (Texas Instrument).pdf

op amps for everyone third edition 2009 (Texas Instrument).pdf



Op-amp application notes from National Semiconductor,

An applications guide for op-amps.pdf

Single rail op-amp design from Texas Instruments

single power supply design.pdf

Various precision op-amp rectifier design.

http://sound.westhost.com/appnotes/an001.htm

From National Semiconductor and Texas Instruments
op_amp_circuit collection_AN-31.pdf
snla140a, Op Amp Circuit Collection.pdf

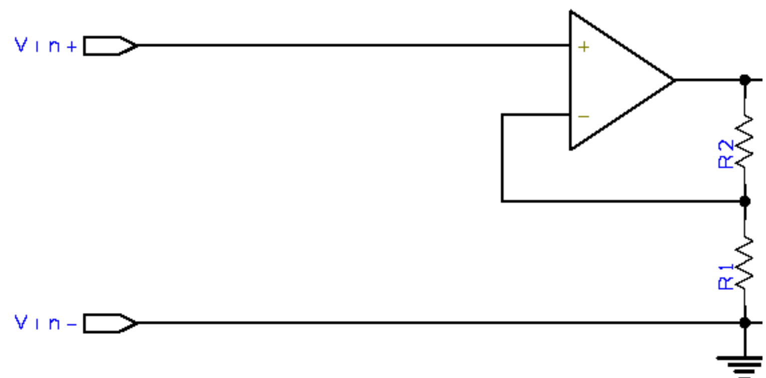
Others
op-amp awith offset (bias).pdf
Single Supply Op Amp Design.pdf
CH9 Paul Smith notes.pdf

Type of Op-amp circuit

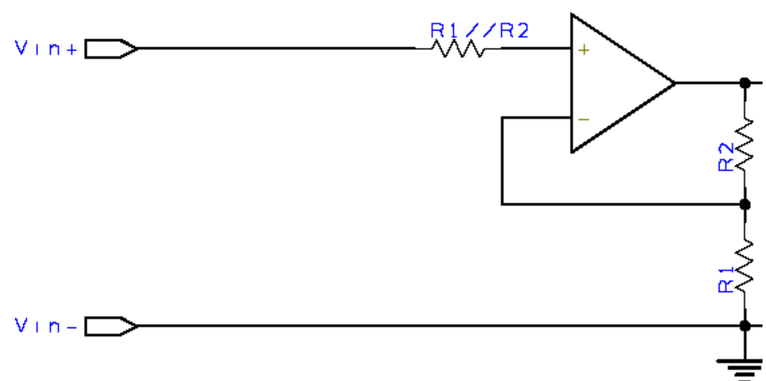
1) Non-Inverting amplifier
2) Inverting amplifier
3) Unity Buffer amplifier (Voltage follower)
4) Differetial amplifier
5) Suming amplifier
6) Instrumentation ampilfier
7) Oscillator
8) Comparator
9) Threshold detector
10) Zero Level detector
11) Schmitt trigger
12) Integration
13) Differentiation
14) Rectifier
15) Logarithmic output
16) Exponential output

1) Non-Inverting amplifier

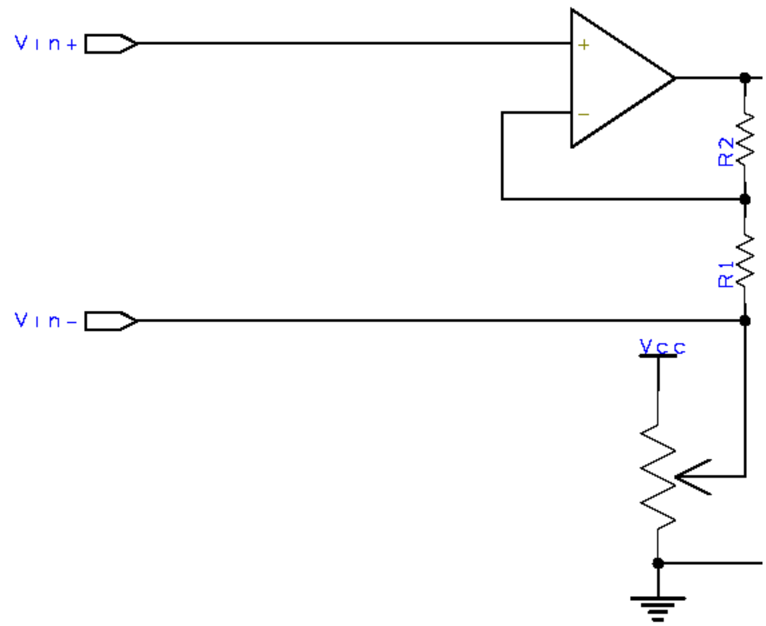
Vout = (1+ R2/R1) Vin
- high input impedance
- low output impedance
- higher bandwidth
- minimum gain of 1



A resistor R1||R2 = (R1 x R2) / (R1 + R2) is inserted just before the +ve terminal will keep the input current better balanced.

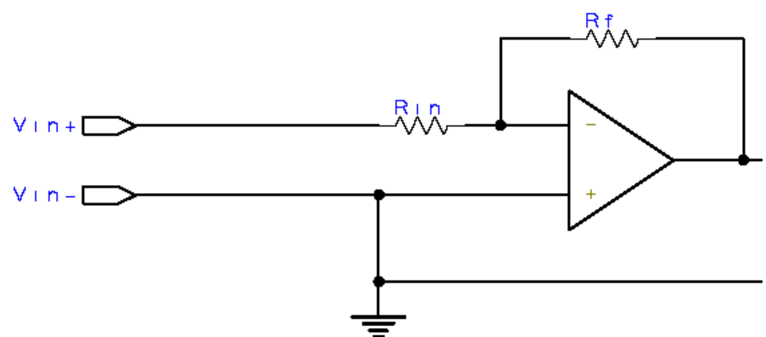


The added voltage divider has introduced a voltage offset to the output signal Vout.



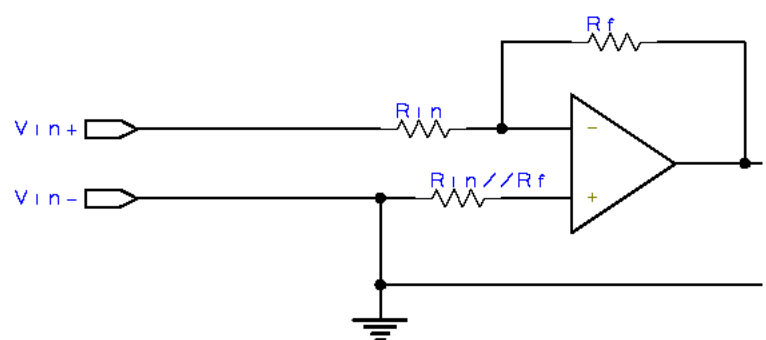
2) Inverting amplifier

Vout = -(Rf/Rin) Vin
- gain can be less than 1

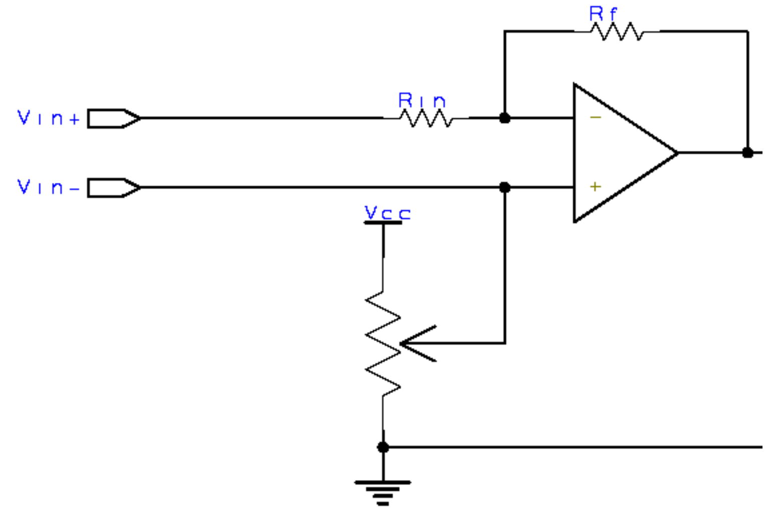


When analysing the op-amp as an amplifier (ideal op-amp), the +ve and -ve is to be having the same voltage potential.

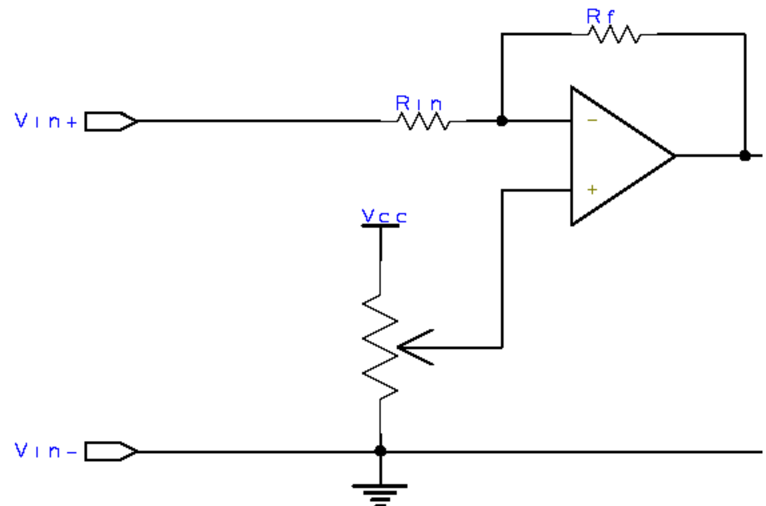
A resistor Rin||Rf = (Rin x Rf) / (Rin + Rf) is inserted just before the +ve terminal will keep the input current better balanced.



The added voltage divider has introduced a voltage offset to the output signal Vout.

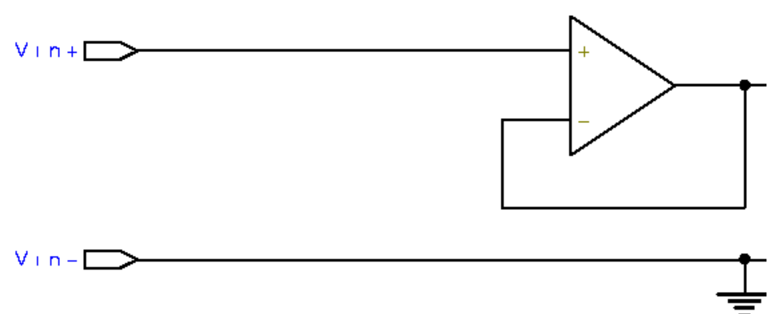


The voltage divider provides a voltage level which the amplification will be based from. Signal with the same voltage level will not be shift in position, while the rest of the voltage level will be amplified.



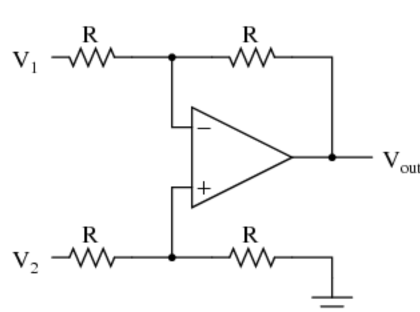
3) Unity Buffer amplifier (Voltage follower)

Vout = Vin
- high input impedance
- low output impedance

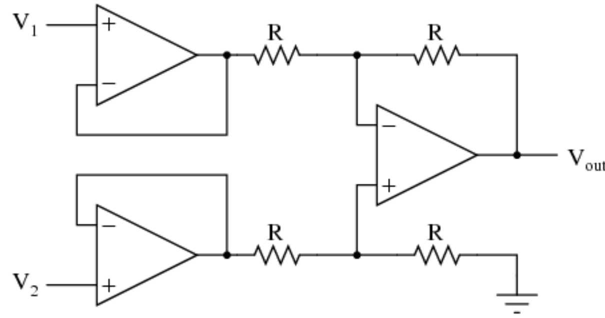


4) Differetial amplifier.

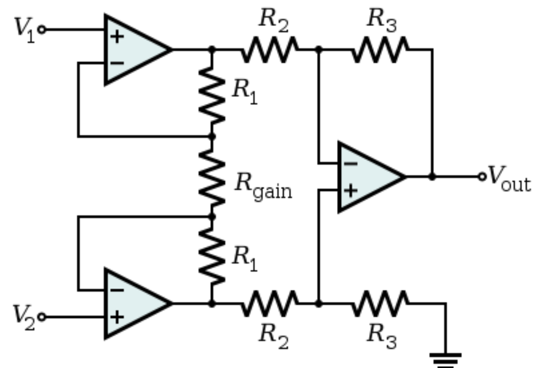
- Poor input impedance



Voltage follower added in the front of the input to improve the input impedance. This is also similar to an instrumental op-amp.



Instrumentation amplifier.



Op-amp Selection

Brand	Part no.	Power Supply	Spec1	Spec2	Spec3	Comment
MAXIM	MAX4242	1.8 to 5.5V (single rail)	Precision 1		-40 to 85°C	clean analog signal (best)
intersil	ISL28276	2.4 to 5.0V (single rail)	Precision 2		-40 to 125°C	clean analog signal
Analog Devices	AD8629	2.7 to 5.0V (single rail)	Precision 3		-40 to 125°C	ok. Can be use for precision Hall sensor project)
Analog Devices	AD8572	2.7 to 5.0V (single rail)	Precision 4 Input Offset 1uV		-40 to 125°C	Seems better and cheaper thar
Analog Devices	AD8602	2.7 to 5.0V (single rail)	Precision Input Offset <0.5mV		-40 to 125°C	(used for LED controller pro;
Analog Devices	ADA4665-2ARZ	5 to 16V, ±2.5 to ±8V	Precision (CMOS) Input bias current <1pA,Input offset 1-6mV		-40 to 125°C	(used for LED controller pro;
intersil	ISL28218	3.0 to 40V (single rail)	Precision		-40 to 125°C	---
Texas Instruments	OPA2374	2.3 to 5.0V (single rail)	Precision		-40 to 125°C	---
Texas Instruments	TLC272	4 to 16V (single rail)	Precision	Output will not reach ±Vcc	0 to 70 °C, -55 to 125°C	general use
intersil	CA3260	4 to 16V, ±2 to ±8V	Normal		-55 to 125°C	single/dual supply applicatio
National Semiconductor	LM321, LM324	3 to 32V, ±1.5 to ±16V	wide supply voltage		-40 to 85 °C	single/dual supply applicatio
National Semiconductor	LM158, LM258, LM358, LM2904	3 to 32V, ±1.5 to ±16V	Normal	Output will not reach ±Vcc	0 to 70 °C, -55 to 125°C	single/dual supply applicatio input offset issue. V+ < V- r positive Vout
Texas Instruments	TLV2402	2.5 to 16V (single rail)	Normal		0 to 70 °C, -40 to 125°C	general use
Microchip Technology	MCP6L02	1.8 to 6.0V (single rail)	Normal 1 Input Offset <1~5mV	Near full swing Vout	-40 to 125°C	general use. Encountered inpu < V- may result in a positive
Texas	TL061	±2V to ±15V	Normal	Output will	-40 to 85 °C,	

Instruments				not reach ±Vcc	-55 to 125°C	
Texas Instruments	TL071	±4V to ±15V	Normal	Output will not reach ±Vcc	-40 to 85 °C, -55 to 125°C	
intersil	CA741, LM741	±5V to ±15V	Normal	Output will not reach ±Vcc	0 to 70 °C, -55 to 125°C	
Texas Instruments	LMV722IDR	2.2 to 5.5V (single rail)		Near full swing Vout	-40 to 105 °C	
On Semiconductor	MC33202DR2G	±0.9V, 0V to 12V		Near full swing Vout	-40 to 105 °C, -55 to 125°C	
National Semiconductor	LMP2022MA	2.2 to 5.5V (single rail)	Precision		-40 to 125°C	unable to it make operating
On Semiconductor	MC33072	3 to 44V		Output will not reach ±Vcc	-40 to 85°C, -40 to 125°C	

(cheap precision op-amp)

Precision usually means a low input offset voltage, which is quite important for voltage comparator, or amplifying small differential input signal.
Input offset <0.5mV will be consider as precision op-amp.
Input offset guide from Analog Device "MT-037, Tutorial Op-amp Input offset voltage.pdf"

Capacitor for Signal Filtering

The following article is a simplied understanding of signal filtering. Basic knowledge of signal filtering is still required before reading this section.

Other references for signal conditioning / filtering
Analog Sensor Conditioning Circuits - An Overview - 00990a.pdf (from Microchip)

The simplest signal low pass filter (LPF) is presented on the right consist of a resistor and capacitor. It is commonly known as RC filter.

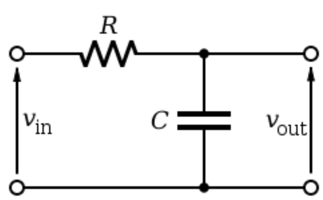
This RC layout is applied to circuit with low impedance input, high impedance output. The resistor will be required to complete the filter function. Signal oscillation may occured is the resistor is omitted.

One example would be LPF filtering at the output of the op-amp amplifier circuitry, where filtering is applied to the varying input signal/voltage.

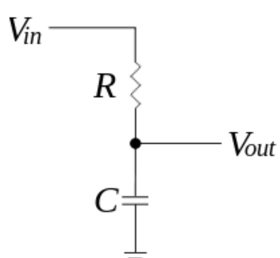
The cutoff frequency of this RC filter
fc = 1/(2πRC)

R will need to be significantly small compare to the load. If the load impedence is high (infinity), then the value of R becomes not very important. If the load impedence is finite, R should be smaller than 1/10 of the load.

Click here for the calculator for the LC filter. frequency and time domain results are on the fly.



RC filter, the simplest low pass filter.



Another way of looking at the same RC filter.

Ideal analysis of the circuit
The signal in the DC or lower frequency signal can be fully transfered to the high impedence (open c

- http://sim.okawa-denshi.jp/en/CRtool.php (generate freq/time domain graph on the fly)
- http://www.2pif.com/high-low-pass-filter.php (simple calculator)

signal will be absorbed on the resistor (R) components.

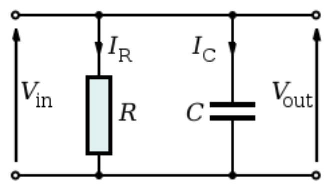
What the high frequency signal will see:
AC signal see resistor as a load, capacitor as a short circuit, while inductor as an open circuit. High frec (C) component as a short circuit. The voltage potential of Vout is seen to be the same as the ground re will be completely absorbed by the resistor R component. High frequency component will not be availa filter.

What the low frequency signal will see:
DC signal see resistor as a load, capacitor as an open circuit, while inductor as a short circuit. Lov capacitor (C) component well. The point Vout is seen to have a very high impedance load. This mean transfer to the open circuit output load at Vout. The R component will be seen as small as compare to voltage divider concept, most of the low frequency signal will fall on the output Vout. The low freque RC filter.

Please note that the above explaination is a simplfied analysis of a filter. Ideal analysis helps us to unde a glance without the need for detail computation. In reality, the open/short circuit represent the degree degree of signal attenuation is dependant on the frequency of the signal and the capacitor's capacitance.

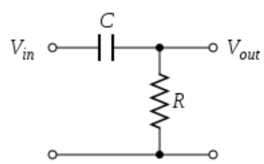
This is another low pass filter consist of only a capacitor. This type of filter will work for current source input. Vin = Vout.

One example would be the capacitors that are found on typical dc power supply filtering at its input or output. Decoupling capacitors (100nF) that are normally found near the power input of an IC is also another example.



A capacitor as a low pass filter.

This is a simple high pass filter (HPF) using resistor and capacitor (RC) components. The ideal analysis is similar to the LPF as anaylzed eariler, allow high frequency signal to pass through while low frequency signal are attentuated.



RC filter, the simplest high pass filter.

Capacitances required to attenuate or suppress signal of certain frequency. Please note that this formula and the table presented on the right is an approximation for filtering noise from a DC signal.

Frequency to Attenuate	Attenuating Factor (Xc)			
	1/√2	1/2	1/10	1/100
50Hz	2200uF	6800uF	33000uF	330000uF
500Hz	220uF	680uF	3300uF	33000uF
1KHz	113uF	330uF	1600uF	16000uF
10KHz	11uF	33uF	160uF	1600uF
100KHz	1.1uF	3.3uF	16uF	160uF
1MHz	113nF	330nF	1.6uF	16uF
10MHz	11nF	33nF	160nF	1.6uF
100MHz	1.1nF	3.3nF	16nF	160nF
1GHz	113pF	330pF	1.6nF	16nF

$X_c = 1 / (2\pi f C)$

$C = 1 / (2\pi f X_c)$

where Xc is the reactance of the capacitor. Xc of 1.0 for the capacitor (open circuit) is possible with lower fequency signal or lower capacitance. To attenuate the AC signal of a particular frequency, Xc has to be low with the correct capacitance implemented.

Max frequency for capacitor (taken from "Op Amps for Everyone")

Capacitor type	Max Frequency
Aluminum Electrolytic	100 KHz
Tantalum Electrolytic	1 MHz
Mica	500 MHz
Ceramic	1 Ghz

Example:

To attenuate a 50Hz signal by 10 times.

$C = 1 / (2\pi \times 50Hz \times 1/10) = 31{,}830uF$

This means that to attenuate the 50Hz component by 10 times requires about 33,000uF capacitor connected from the signal to the ground line. This capacitor will filter any frequncy >50Hz on the line.

The table on the right is a simplified guide, which recommend the capacitance to use as a low pass filter for attenuating a particular frequency.

The table on the right summeries the typical capacitor value available commercially.

Standard Commercial Capacitor Value:

pF	pF	pF	nF	nF	nF	uF	uF	uF	uF	uF
1	10	100	1	10	100	1	10	100	1,000	10,000
1.1	11	110	1.1							
1.2	12	120	1.2							
1.3	13	130	1.3							
1.5	15	150	1.5	15	150	1.5	15	150		

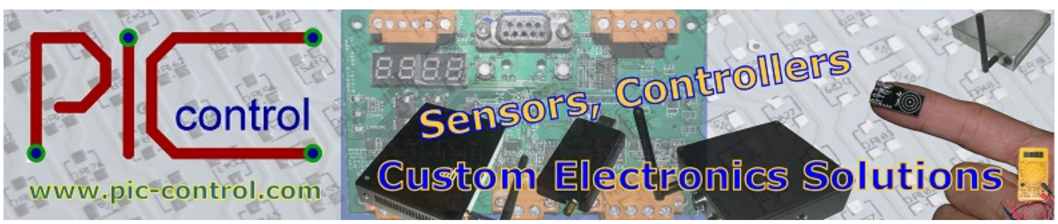
1.6	16	160	1.6								
1.8	18	180	1.8								
2.0	20	200	2.0								
2.2	22	220	2.2	22	220	2.2	22	220	2,200		
2.4	24	240	2.4								
2.7	27	270	2.7								
3.0	30	300	3.0								
3.3	33		3.3	33	330	3.3	33	330	3,300		
3.6	36	360	3.6								
3.9	39	390	3.9								
4.3	43	430	4.3								
4.7	47	470	4.7	47	470	4.7	47	470	4,700		
5.1	51	510	5.1								
5.6	56	560	5.6								
6.2	62	620	6.2								
6.8	68	680	6.8	68	680	6.8	68	680	6,800		
7.5	75	750	7.5								
8.2	82	820	8.2								
9.1	91	910	9.1								

Active filter with op-amp

For flat frequency response, use Butterworth filter

For a sharp cutoff frequency, use Chebyshev filter

For linear phase, use Bessel filter.



Transistor Switching

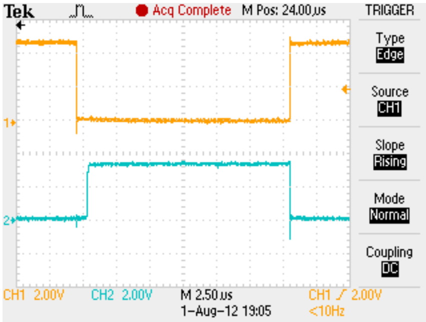
I didn't realised that transistor switching speed can be so important until I had encountered a pro
The data communication gets corrupted. Go through all the codes, and eventually found that th
The current batch of transistor is different from my previous batch; and I always thought that a
am wrong, it is not. The problem might have been due to my design as well, unable to discharge
transistor.

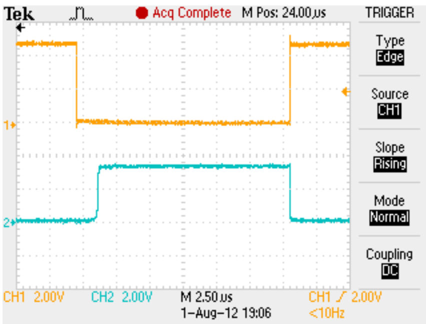
Ch1(yellow) shows the signal input through a 1kohm resistor to the base of the npn transistor. C
collector terminal, with a pull up resistor of 560ohm. The is

The following present the various BC817 transistor's switching digital speed.

Switching speed of my original transistor.

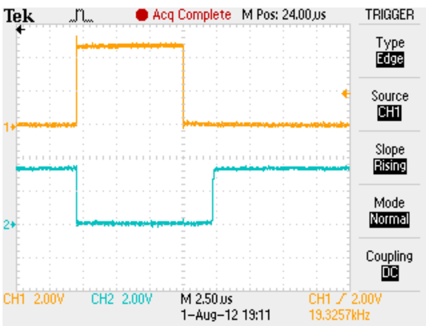
delay of about 0.7us.





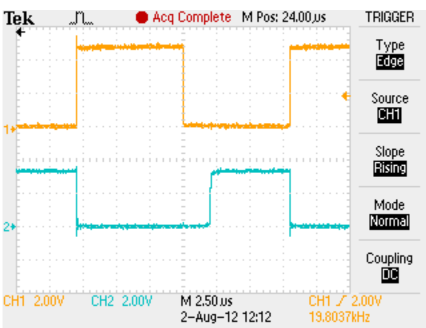
using npn BC846

delay of about 2us.



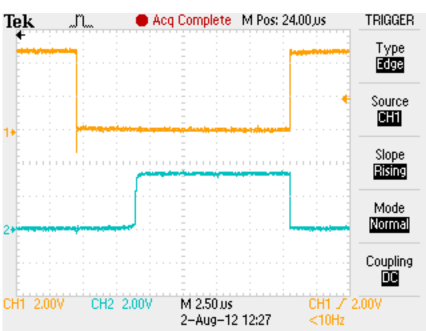
using npn BC817

delay of about 2.5us.



BC817-16LT1G

delay 2us

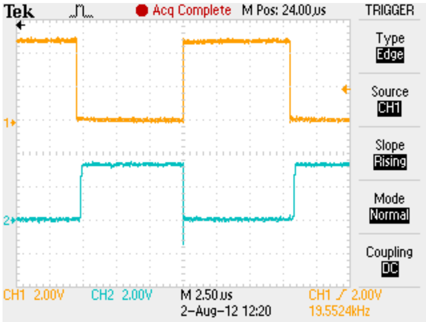


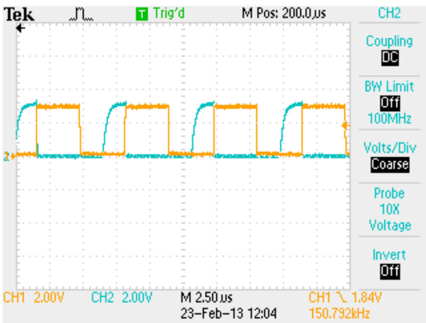
MMBT4401LT1G

delay 4.5us

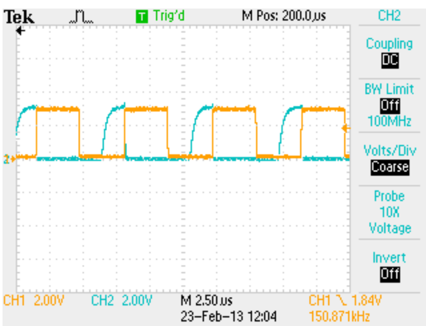
MMBTA05LT1G

delay 0.25us



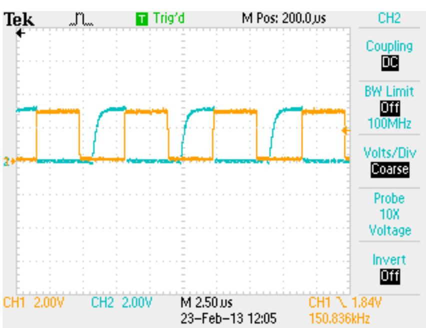


Effect of the signal switching without a resistor across the Vbe terminal of a npn transistor BC8



Effect of the signal switching without a 10kΩ resistor across the Vbe terminal of a npn transisto

There is a slight improvement in delay, but not very noticable.



Effect of the signal switching without a 10kΩ resistor across the Vbe terminal of a npn transisto

More than 100% improvement shortening the delay, of the inverted signal by about 1us.

email: mail@siongboon.com
website: http://www.siongboon.com

Keyword: op-amp, buffer, inverter, amplifier

Radio Frequency Experiment by BH1RBG

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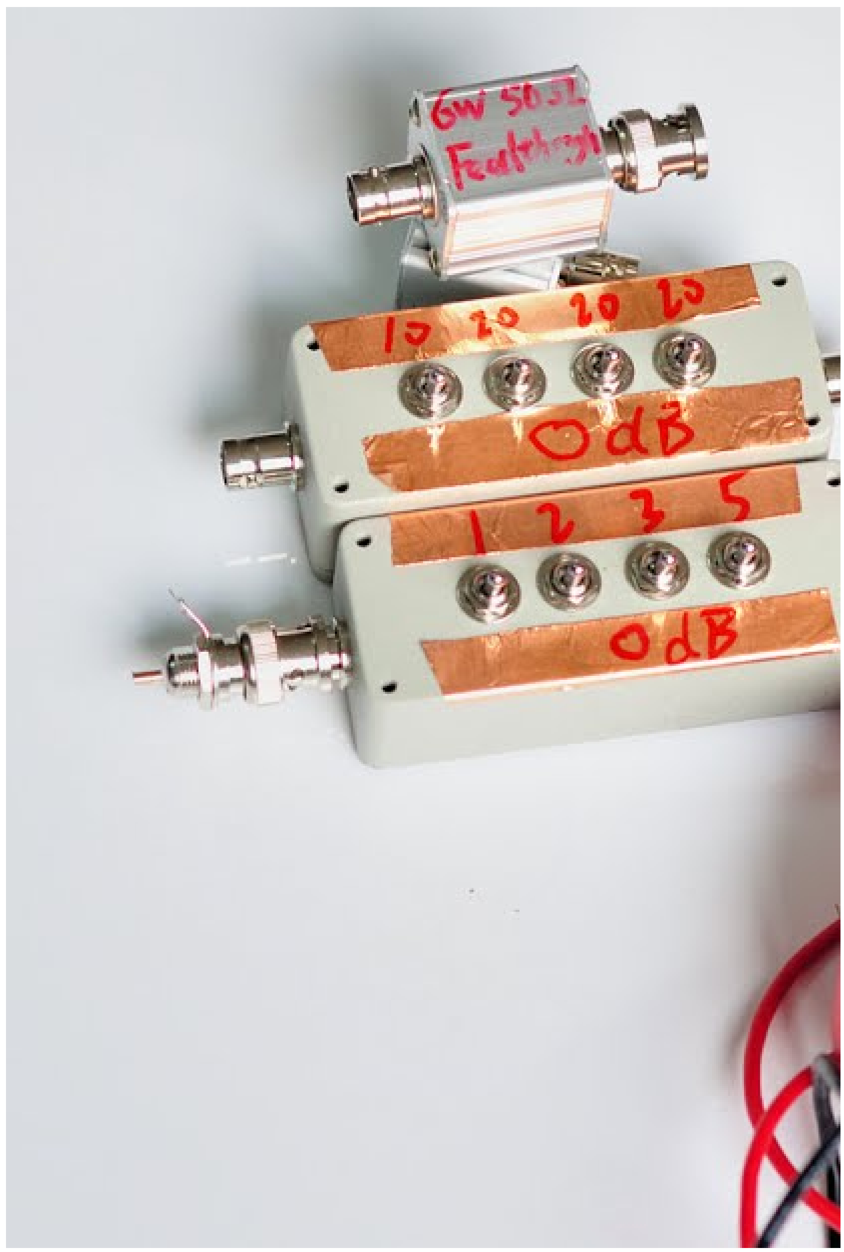
  - **Run into Wide-Band Buffer/Amplifiers**
  - **Super Regen: Make it work**
- **Homebrew Craft**
  - **Air Coil 4.5 Turns example**
  - **experimental board**

RF Homebrew Instrument >

Attenuator: 50ohm/81dB 1dB step

Created@2012/12/15

(finished by 2013/1/14, one month hard work)



Fuse based dead bug
RF Calculators
Heterodyne tracking calculator
RF Experiment
AMP: Simple RF Amplifer
Antenna: JFET active attenna
Audio: 2 stages Transformer Audio PA
Audio: Discrete Power Amplifer
Audio: low distortion wein bridge
Audio: Pre-amplifer 2011
Audio: Push Pull PA
Audio: Simple power amplifier
Audio: wein sine bridge
Bias: favorite BJT/JFET bias guide
CXO: CXO/overtone for TX
CXO: Low distortion oscillator
CXO: Tune 5th Butler Overtone VHF Oscillator
Fail: CB Negistor-not work
IF: BJT 2 Stage with AGC
LiPo: Simple charger
Miller negative resistance Oscillator
Mixer: JFET active mixer
Oscillator amplitude stabilization
Ramp: linearity ramp genarator
Ramp: Versatile ramp generator
SA: What is SA (SA demo prj)
Supply: dual Li-Po 7.2V-8.2V
Sweep: Build new topology signal source
Sweep: simple Hartley Sweeper
VCO: Franklin 80Mhz-180Mhz
VCO: AM Hartley LO
VCO: CB colpitts 270Mhz-500Mhz
VCO: Improved Series E VCO
VCO: linearity factor
VCO: Negative resistance VCO
VCO: Negative VCO Linearity
VCO: Seiler 80Mhz-300Mhz
VCO: Ultra Negtive 100kHz-100Mhz
VCO: Vackar 30Mhz-240Mhz
VFO: ultra-audion LF to VHF
VFO: AM band Oscillator
VFO: hybrid feedback oscillator
VFO: Several Dipper Ocillators
VFO:New topology of Series-E oscillator
RF Ham Radio
10M:28.6Mhz FM transmiter
27Mhz: AM RX/TX Experiment
AM: AM band transmiter by Techlib
Antenna: Your first Antenna

The basic tools for RF, you must have one.

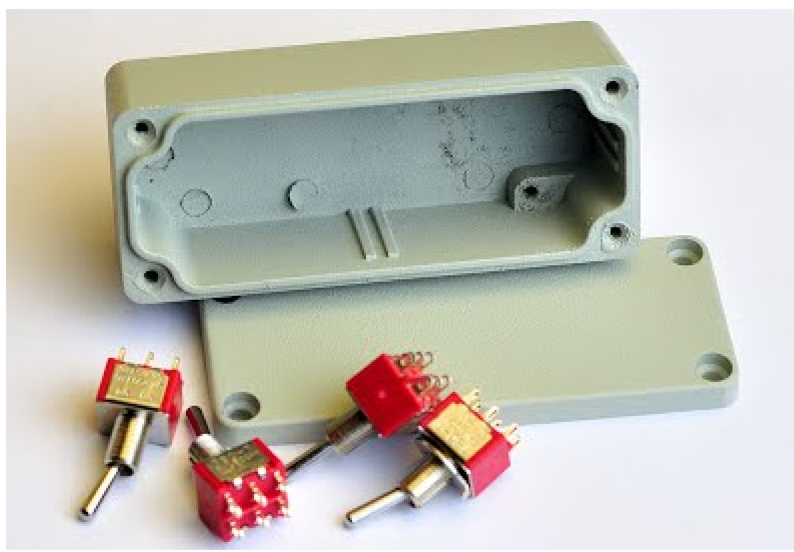
Attenuator Plan and select box

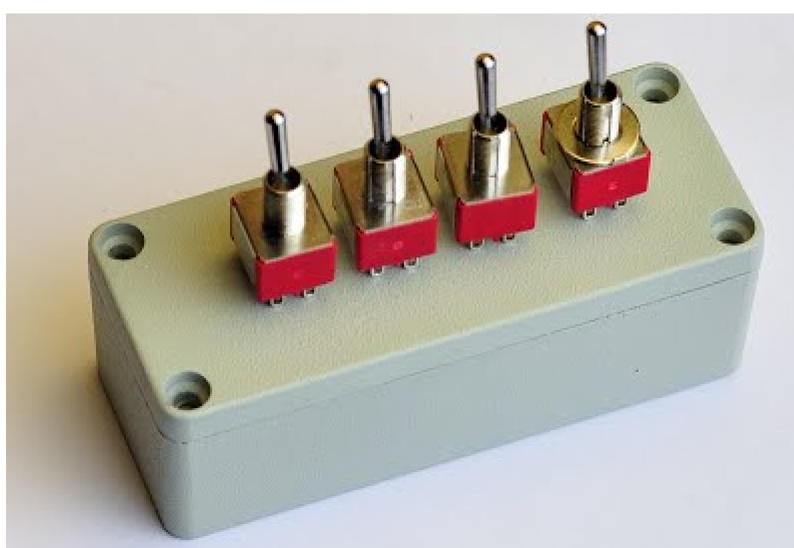
2 box, the one given following attenuation step:
1dB 2dB 3dB 5dB

another :
10dB 20dB 20dB 20dB

Design goal:
*RL>60dB at DC
*RL>40dB at VHF
*usable to 70cm band

the die-casting aluminum box image: (9cmx3.6cmx3cm)





DC: Improvise Better Polyakov
DC: Polyakov The First DC receiver
Experience Crystal Set up to Superhet
FM Synchrodyne
Heterodyne: BJT AM receiver
Heterodyne: Build A Traditional Radio
HF: 0.5W Linear push pull PA
Regen: Aamazing Regen Receiver
Regen: High Performance Rig
Rflex: with voltage doubler detector
SuperRegen: AirCraft band receiver
TRF : the origin of Receiver
TRF: infinity JFET 0V2
RF Homebrew Instrument
3D printer make RF fun and cool
Attenuator: 50ohm/81dB 1dB step
Attenuator: 600ohm 1dB Step
Attenuator: Serebriakova 13-40dB
Audio: low THD two tone generator
BAT:servo constant current load
Bias: JFET Bias tool box
Bridge: RLB VHF
Couter: EP frequncy counter
Crystal: checker
LiPo:Dummy Blance charger
NICD: Dummy Discharger
Power Meter: AD8307
Power Meter: Calibrator
SA: PC sound card oscope
Sawtooth: Ramp signal source
Signal: Build The Log Detector Sweeper
Signal: Improve The Log Detector Sweeper
Signal: Prototype of Log Detector Sweeper
Sweep: boostrap sweeper
Sweep: manual sweep signal source
SWR: the Good HF QRP SWR
Sitemap

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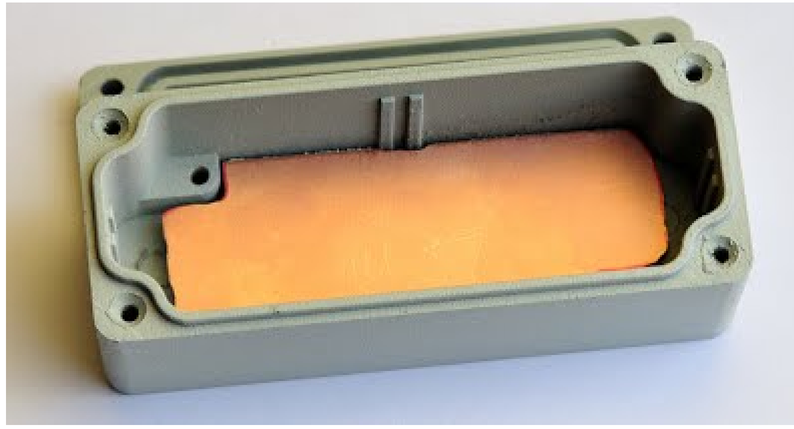
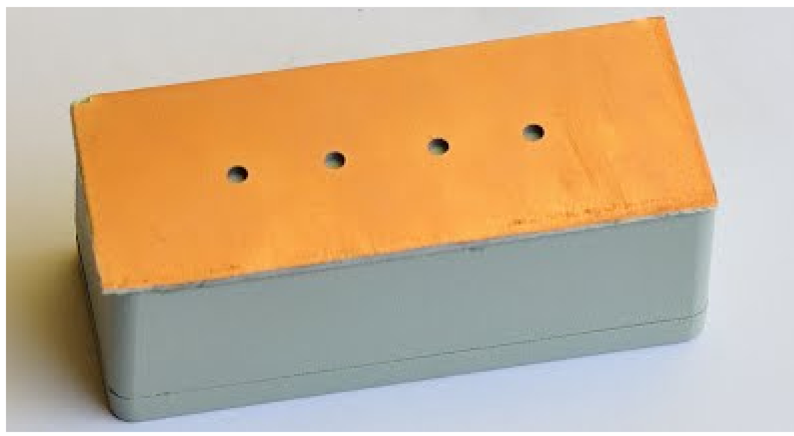
G+

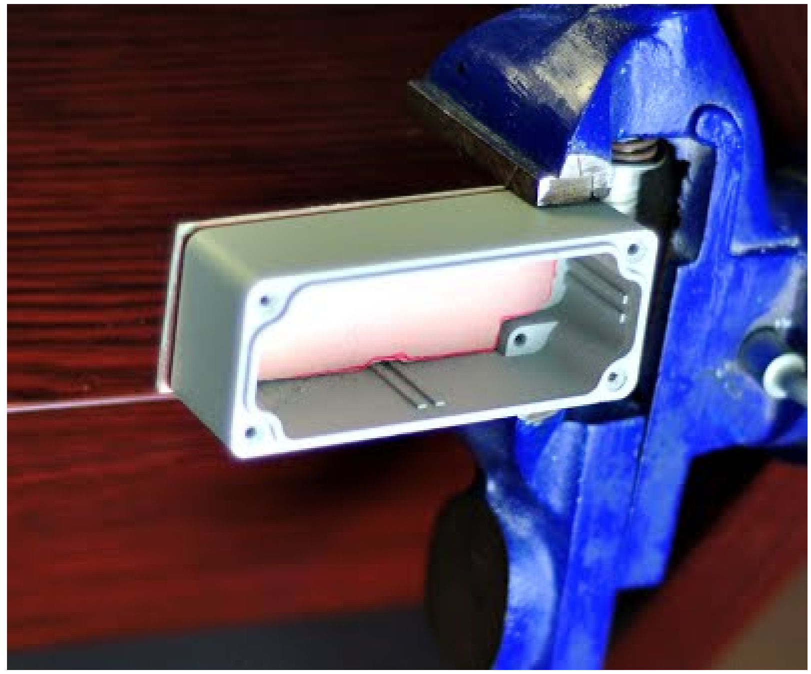
Create drill Stencil

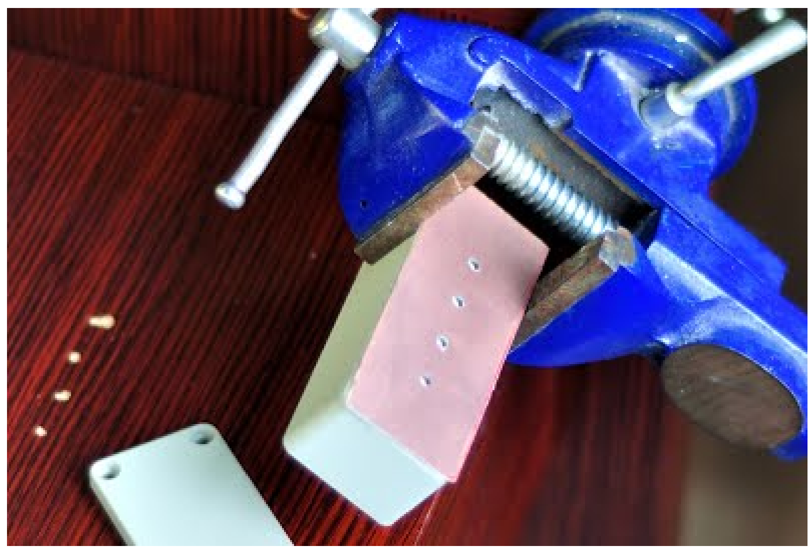




drill with Stencil

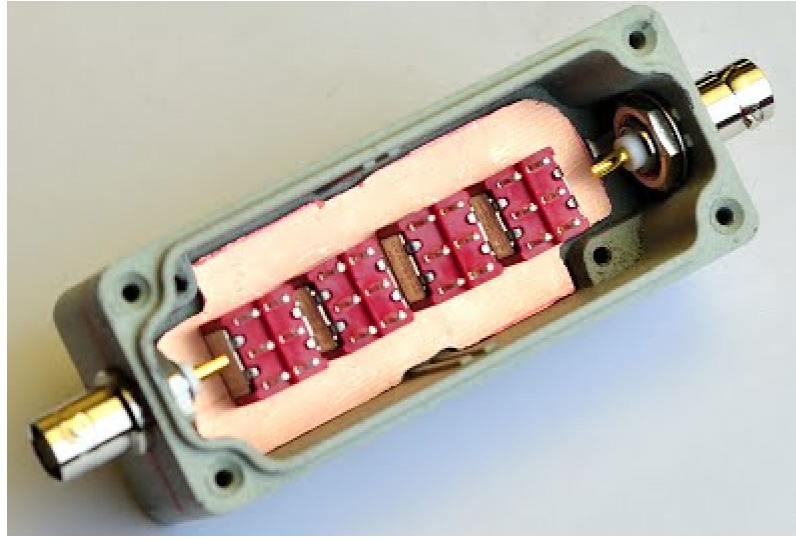
when finished, the drill Stencil will use as secondary PCB box provide excellent shield.



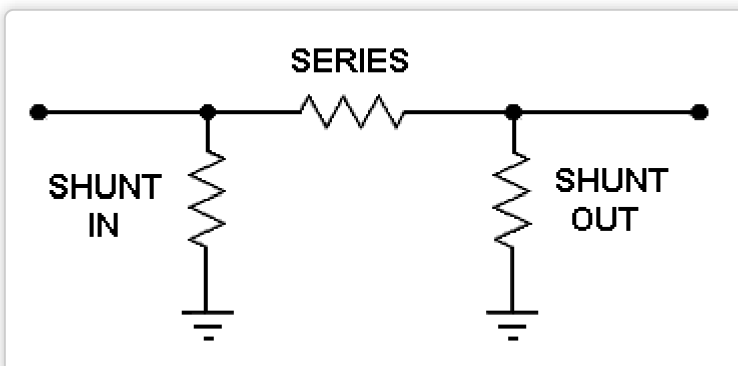


checking after drill finished

.



Get Ideal resistor from 5% series



use %5 1/4W resistor, here is a method to get ideal resistor for attenuator: select a closed 5% resistor which big than the wanted value, then parallel another resistor to get perfect resistor. typically <1R to perfect attenuator value, even 0.5R.
First of all, you should have at least a 4.5 digital DVM or equivalent device.

for example, you want 5.769 ohm,
1) then pick 6.2R, in this step use a less value, ie, you 5% resistor had 6.0,6.1,6.2ohm, then use 6.0.
2) then try to parallel a 68ohm resistor on it, check it with you DVM, if you get ie, 5.3ohm, if you accept this, done. if not
3) 5.3ohm<5.769, we should try use large resistor, try 75R,82R ....

here is all the matched pair for your start to get your ideal resistor, after the "=" is the value i get, and I'm very happy to get these perfect value resistor.

perfect closed
1dB: shunt: 869.548 **910||22**k = 868
Input RL: >73dB
series: 5.769 **6.2||68**=5.75
Out RL:>73dB

perfect closed
2dB: shunt: 436.212 **470||7.5k** = 436.4
Input RL: >78dB
series: 11.615 **12||430**=11.60
Out RL: >78dB

perfect closed
3dB: shunt: 292.402 **300||16k** =292.5
Input RL: >75dB
series: 17.615 **18||1.1k**=17.6
Out RL: >75dB

perfect closed
5dB: shunt: 178.489 **200||1.8**k =178.6
Input RL: >60dB
series: 30.398 **33||430**= 30.49
Out RL: >60dB

----

perfect closed
10dB: shunt: 96.248 **100||3.9k** = 96.3
Input RL: >70dB
series: 71.151 **75||1.3k**= 71.1
Out RL: >70dB

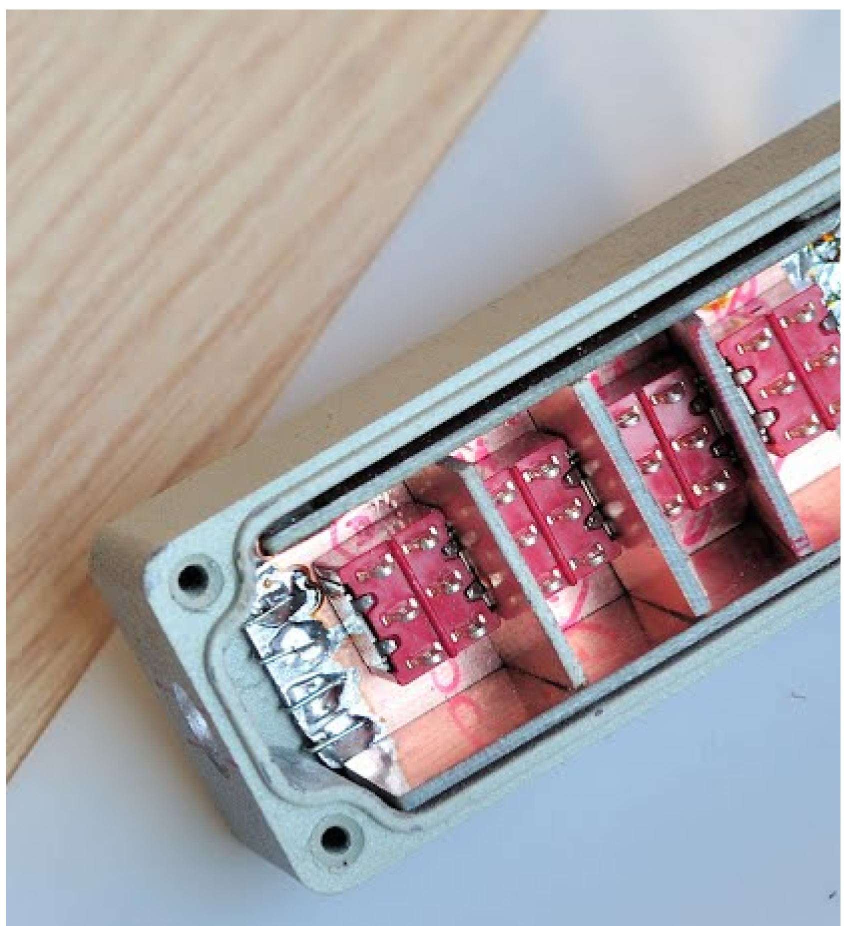
perfect closed
20dB: shunt: 61.111 **62||3.3k** =61.10

Input RL: >70dB
series: 247.502
270(265.3)||3.9k(3.83)=247.8 Out RL: >70dB

Making secondary PCB shield box fit into the die-casting box

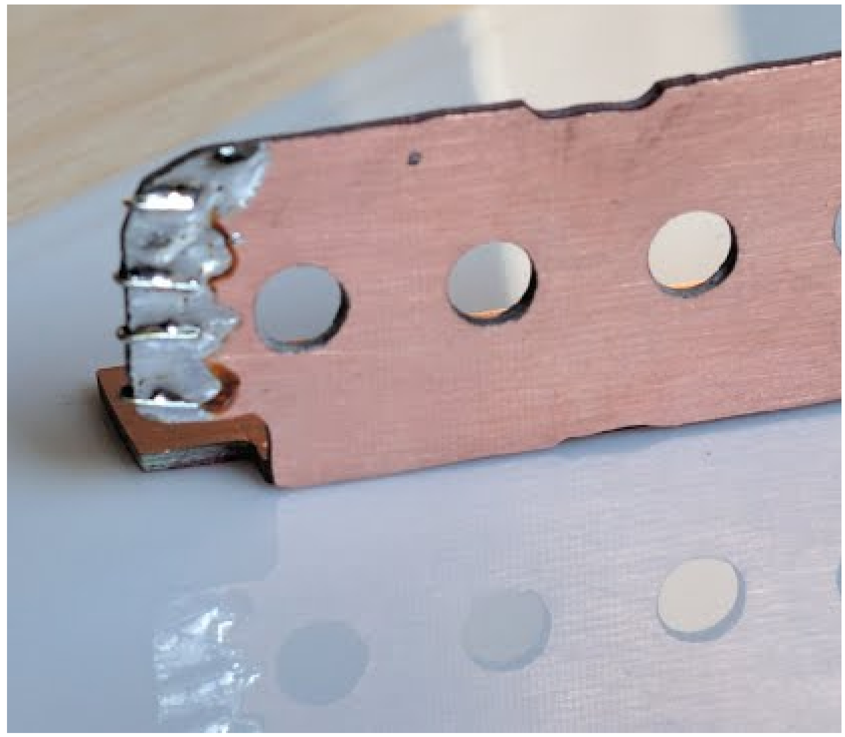
drill mask used as another PCB box's panel, then we need more PCB parts to form a box. the following image show how to make many same size parts one time.

When finished all parts, put them into die cast box, checking if the dimension is suitable. \

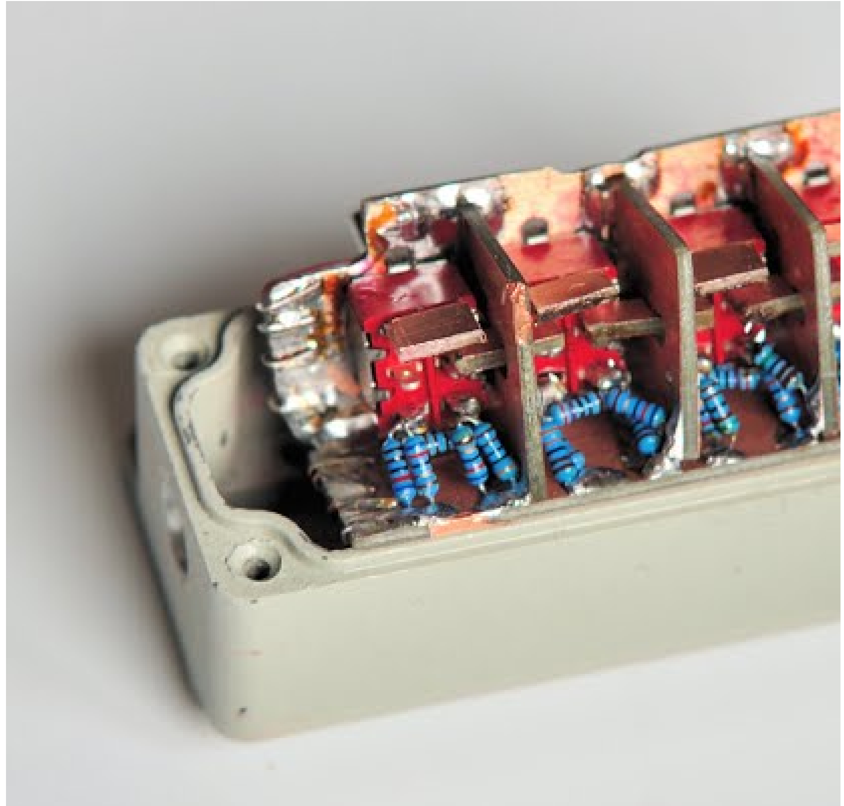


Soldering the PCB shield box

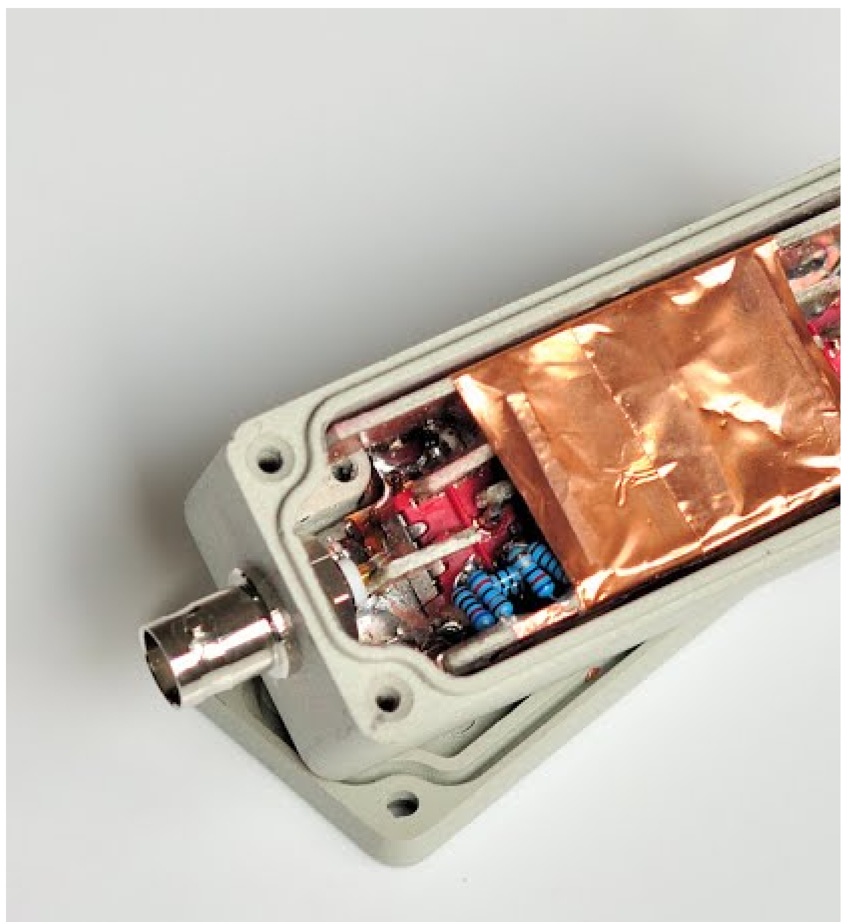
NOTE:
1. use wire to connect bottom and the top layer of the PCB



2. use PCB strip to connect the switch for better performance at high frequncy. you should make through hole for inter connect.



3. use copper tape seal the bottom



DC checking

Use a 4 1/2 digital DVM, a 50R load, a battery to check the DC resistance and the DC attenuation. this ensure all of them connected properly and given a low Frequency attenuation reference.

battery -> attenuator -> 50R load

Attenuation=20*log(Vout/Vin)

1. resistance check
terminated by 50R, test another port resistance

1db/2db/3db/10db/20db : 50.05R
5dB: 50.10R

2. DC attenuate

1dB:	in: 1.2983	out:1.1572	0.999 dB
2dB	in:1.2978	out: 1.0316	1.994 dB
3dB	in: 1.2976	out: 0.9186	3.000 dB
5dB	in:1.2975	out: 0.7289	5.009 dB
10dB	in:1.2980	out: 0.4101	10.007dB
20dB	in:1.2977	out:0.12931	20.03 dB

@2003/9/22

few day ago i finished the 8307 Power Meter, which work really good up to 470Mhz(which i can test by a handy transceiver with 40dB pad attenuator) , so can verify the high frequency performance.

10Mhz testing(pending)
dam good.

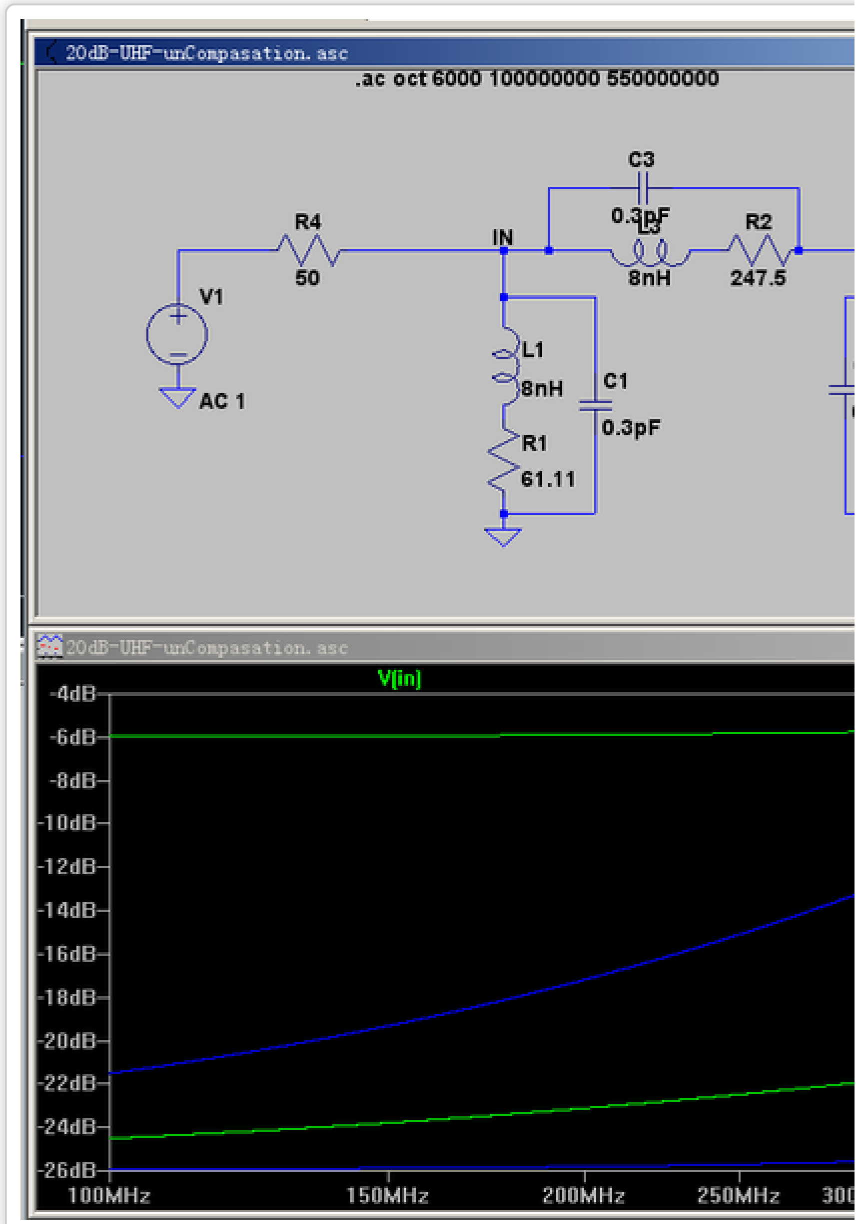
144Mhz testing(pending)
really good.

455Mhz testing(pending)
1-10dB is fine, but with 20dB, only get 18~19db attenuation.   refer following sections.

@2003/9/22

compensation the step attenuator up to 500Mhz

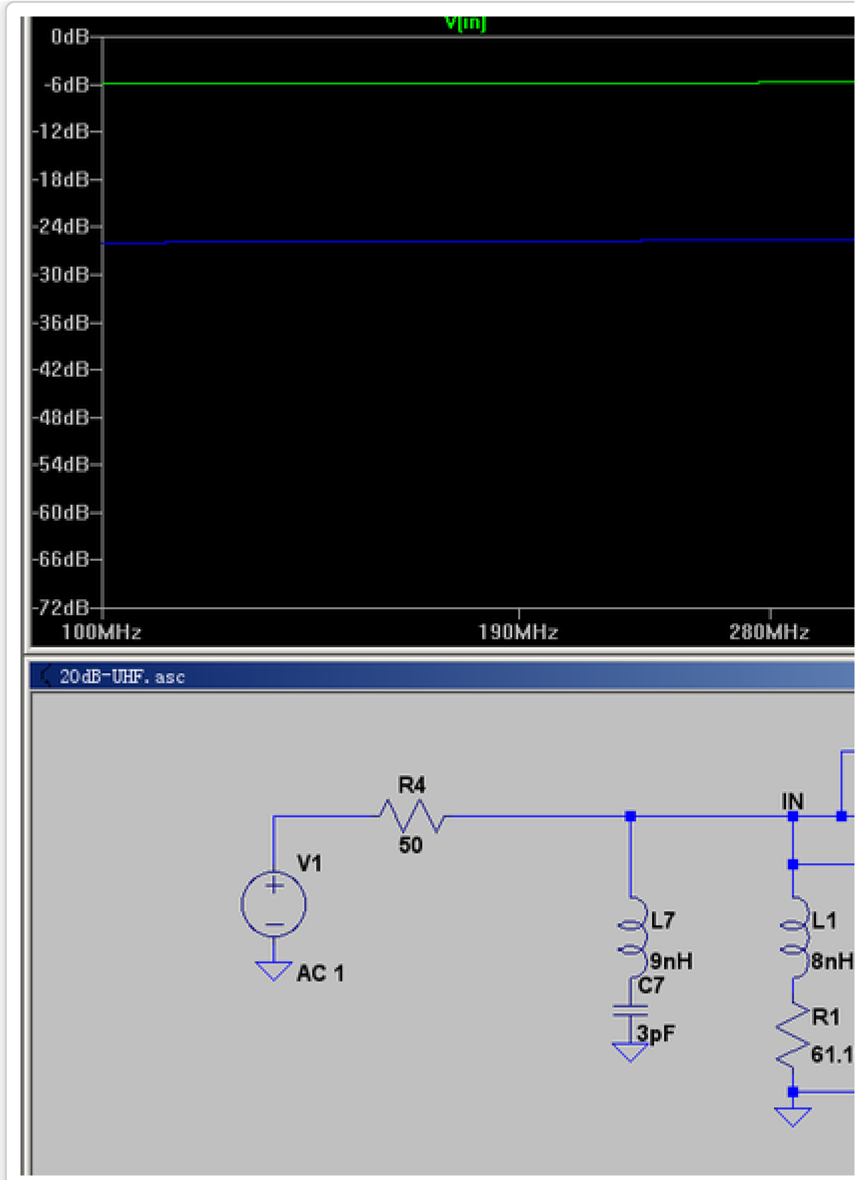
here is the simulation with LTspice, a typical axial 1/4 Watt resistor might have 8nH parasitic inductance and 0.3pF pakage ((which should less than 8nH, i cut the lead is damn short). with these i do get the seems fit the reality performance.



Note: the lower blue line is the attenuation.

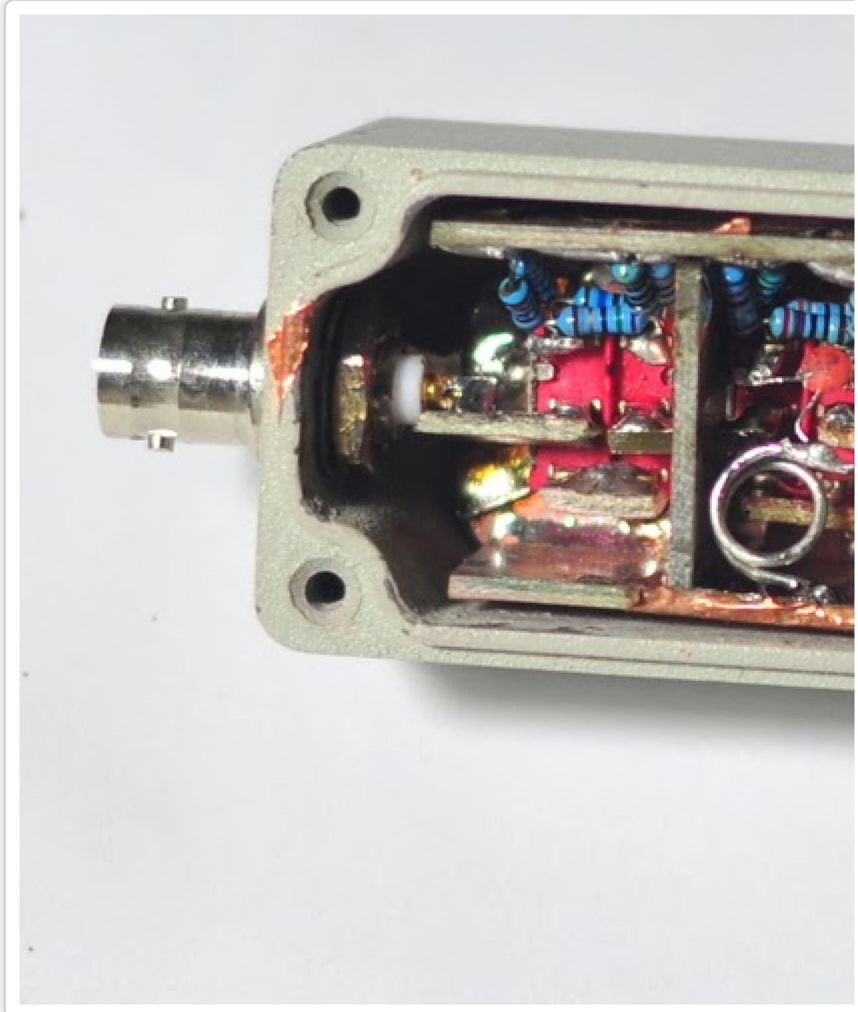
how to compensate this? learn something from the AD8307 compensate method, i can use a 3pF capacitor with long lead bend to a 5mm diameter inductor, witch should around 8nH~9nH. I got this simulate result:

Simulation tell me such things should work, let's check it tonight!   so much effort to construct this device, but axial version seems hard to work to 500Mhz.



compensation Version

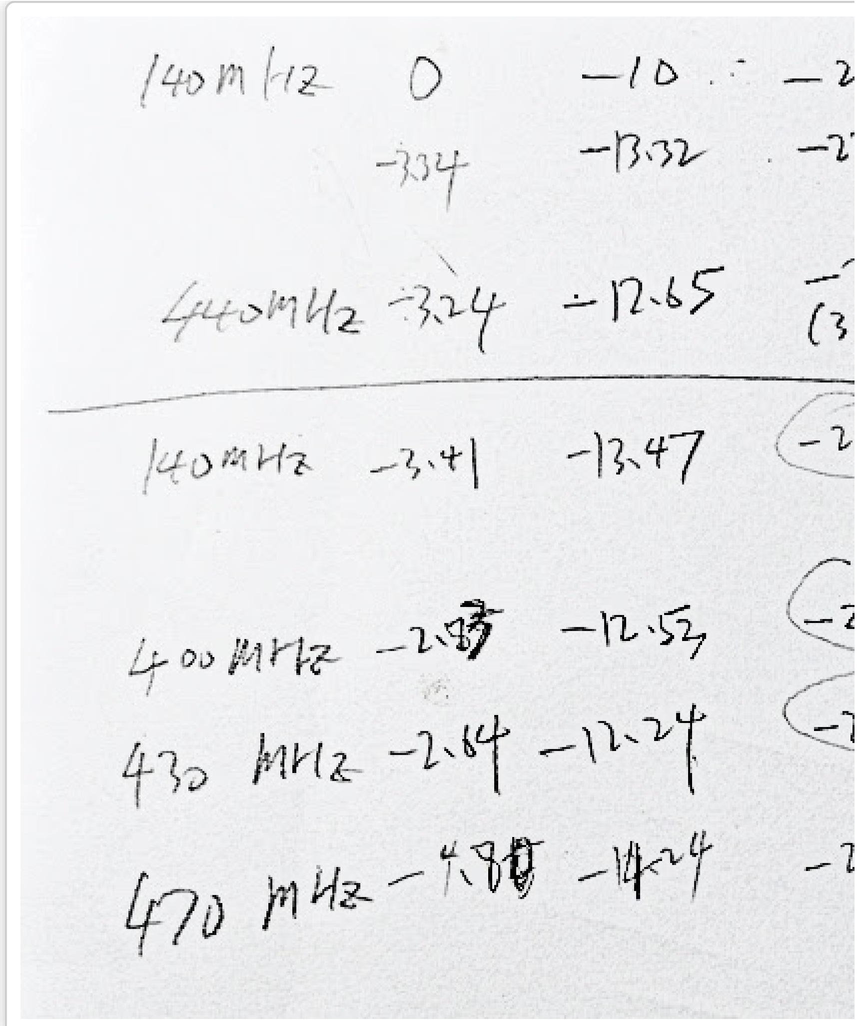
here is the picture finished compensation:



Final Result:

below the line is compassionate version, accuracy improved 2.x dB from 140M to 470Mhz.

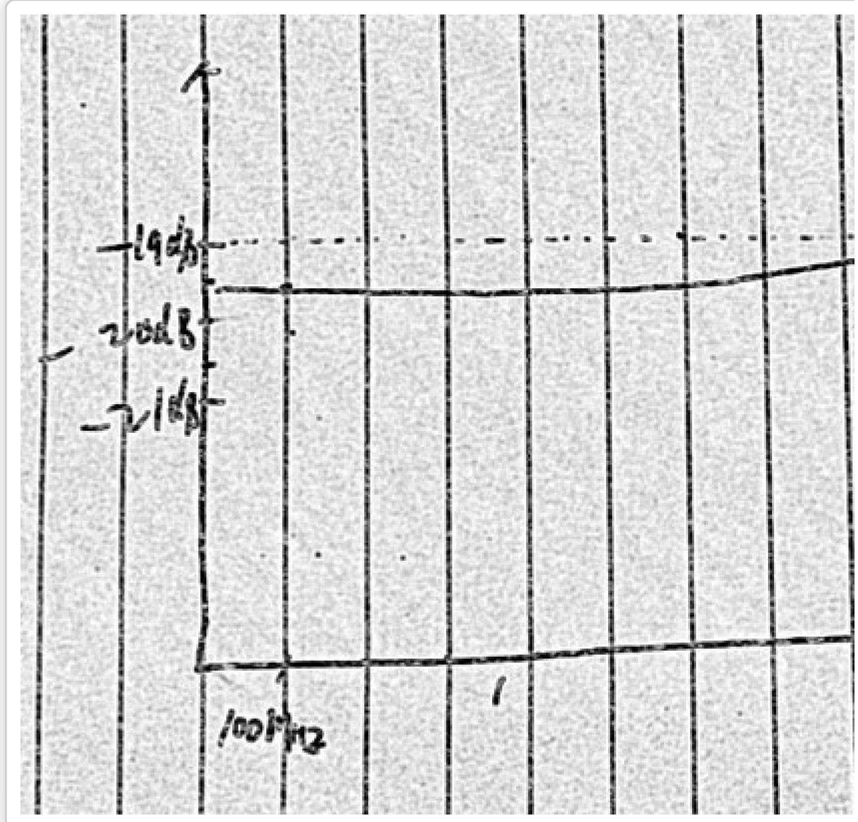
(column 0 means the signal strength when enumerator set to 0, -10 represent the signal when 10 db switch in)



Conclusion @2013/9/23

***1- 10dB** attenuation and are useful up to 500Mhz, less than 0.5dB error (up to 500Mhz).
*20dB attenuation are accuracy up to 150Mhz, error less than 0.5dB after compensation.
*from 200 to 450Mhz error less than -1dB.
*470Mhz get +1 error attenuation.
* 1-10dB + 2X20dB is useable, but 3x20dB won't work...... (might because signal leak?)

*Compensation is work but limited, seem, it's hard to tune it to cut at 900Mhz and keep error < 1dB



Comments

You do not have permission to add comments.

Automatic lamp

Automatic lamp

Lamp will switch on automatically if ambient light will be low. P1 trimpot adjust light time between 1 and 26 seconds. Lamp has a very low idle supply current. Lamp uses dual monostable flip-flop 4538. First monostable light-on time. Second monostable blocking first when the lamp goes off and prevent restart it. Manual switch between automatic light-on mode and pernament light-on mode. Lamp is powered from one Li-ion cell. On PCB can be placed charger from Fig. 2.

Surely you've already happened: you're sleeping on a mountain cottage, for example, and you're going to sleep. At the door you turn off the light and then, in an unfamiliar environment, carefully gently scrambling to your bed and trying not to interfere with anything. In that case, you might want to use the lamp described here, which will automatically turn on for a few seconds if it suddenly fades. The lamp responds only to the light extinguishing, and does not light up slowly when it fades slowly. The lamp compartment is designed to have negligible power consumption, it does not have to switch off and the lamp battery lasts without charging long.

Specifications

Supply voltage: Supply voltage:	3.5 - 5 V (3-15 V with changed R5).
Current consumption at standstill at 4 V: Idle supply current:	less than / less than 1 µA.
Light-on supply : Light-on supply current:	according to LED current. depend on LED current
Car time. lighting: Automatic light-on time:	1 - 26 s.

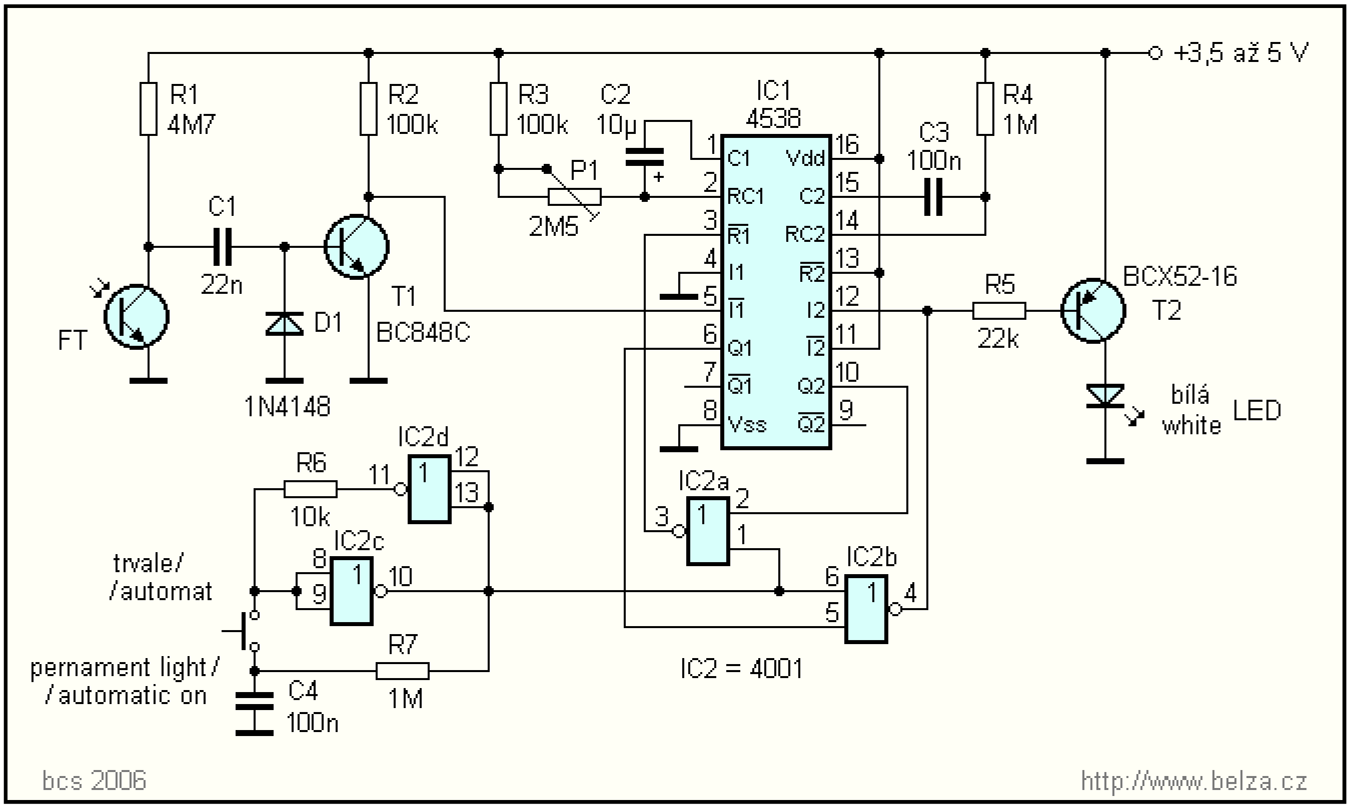


Fig. 1. Connecting the automatic lamp
Fig. 1. Automatic lamp circuit drawing

Description involvement

The connection of the lamp is in **figure 1** . Note first the bistable flip-flop with IC2c and IC2d gates. The button switches whether the lamp lights up permanently or switches on automatically. Suppose the logic level is now in the auto-ignition mode and at the gate exit. 0. The intensity of the light is captured by the FT phototransistor. In case of sudden darkness, the phototransistor closes and the capacitor C1 is charged via resistor R1. The transistor T1 opens with charging current and the first monostable flip-flop circuit (IC) in IC1 is triggered on the collector. With slow dimming, C1 is charging slowly and the charging current is not enough to open T1.

The monostable CMOS 4538 flip-flop circuit has a number of advantages over the 555 timer MFP: It is switched by an edge rather than a level, and we can select an input that responds to a leading or descending edge. It has two complementary outputs so we do not need to invert the output signal when we need it with the opposite level. Further, for this construction, the key feature of the circuit is that it has practically zero consumption at rest. The CMOS timer 555 has a current consumption of approximately 100 µA at a voltage of 4 V, whereas at this lamp the largest current flows through resistor R1 (about 0.9 µA); in the dark the collection is even smaller.

When MKO1 is triggered, level H is displayed at output Q1 (terminal 6 IC1), and then level L is output at gate output IC2b. Transistor T2 opens and LED1 illuminates. The tilting time of MKO1 can be adjusted by the P1 trimmer. After the set time has elapsed, output L1 appears at the output Q1, at the gate output IC2b level H and LED1 goes out. However, it is necessary to ensure that its extinction does not start MKO1 again. This is done by the second MKO in the IC1 housing, triggered by the leading edge at the input I2 (terminal 12). During the flip-over of MKO2, level H is reached at the output Q2 and at the output of gate IC2a level L. This signal is applied to the zero input MKO1 (terminal 3). The MKO1 is blocked during the rollover of MKO2 and can not be restarted. Therefore, the LED1 may also light up on the phototransistor, thus the function of the lamp is not disturbed. MKO2 rollover time, here about 100 ms, accommodates common white LEDs, thanks to the luminophores, can last up to several tens of milliseconds. If a bulb was used for lighting, it would be necessary to extend the flip-over time of the MKO2 by increasing the capacity C3 and / or resistance R4.

If necessary, the lamp can be permanently lit by pressing the button. The output level of the IC2c gate will show level H. At the output IC2a the level L will appear to reset and lock the MKO1. At the same time, the L level appears at the output of the gate IC2b and the LED1 lights up. The lamp can be extinguished by pressing the button again. At the same time, the MKO2 starts and momentarily blocks the MKO1 so that it does not start again by switching off the LEDs, as in the automatic mode. Note that by double-clicking on the button, the LED1 automatically switches off automatically because the manual illumination will reset MKO1.

I used one white LED to light up. New types of diodes have a luminous intensity of up to 50 cd when supplied with a 20 mA current, and their illumination for the orientation is sufficient. Appropriate LEDs are sold by, for example, [AC / DC Audio]() or [Flajzar]() . The LED is powered by a transistor T2, whose collector current is dependent on the current to the base and can be changed by resistance of resistor R5.

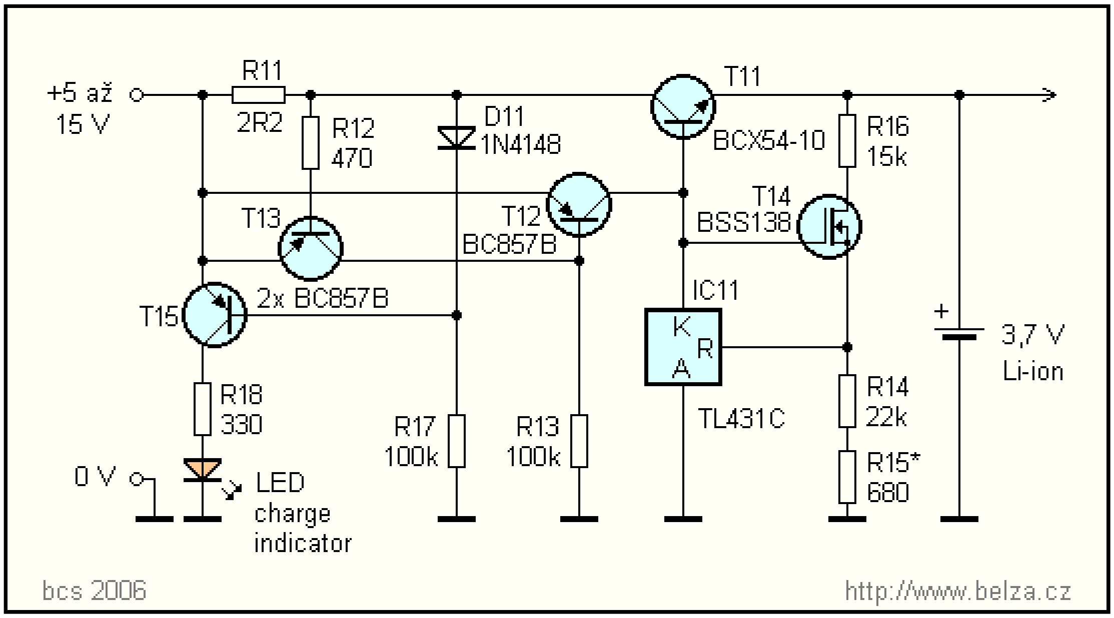


Fig. 2. Charger for the lamp battery
Fig. 2. Li-ion accu charger

I used a disposable Li-ion battery from the laptop battery to power the lamp. The battery has a larger internal resistance, which does not matter when taking the order of dozens of mA. Similarly, we can use "tightened" batteries from mobile phones. The lamp is completed with the charger **shown** in **Figure 2** . The battery in the lamp can be recharged, for example, by the charger from the mobile phone or from the USB port of the computer. The charger connection is [described in detail here]() .

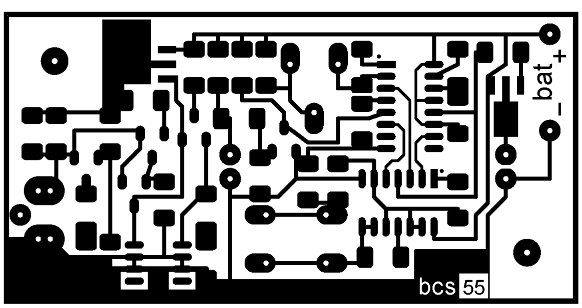


Fig. 3. Circuit board with automatic lamp. If you use the right mouse button and select "Save image as", you get a 600-dpi master template. The board has a size of 30 x 60 mm.
Fig. 3. Automatic lamp with PCB layout. Click right mouse button and choose "Save image as" to get 600 dpi resolution image. PCB size is 30 x 60 mm.

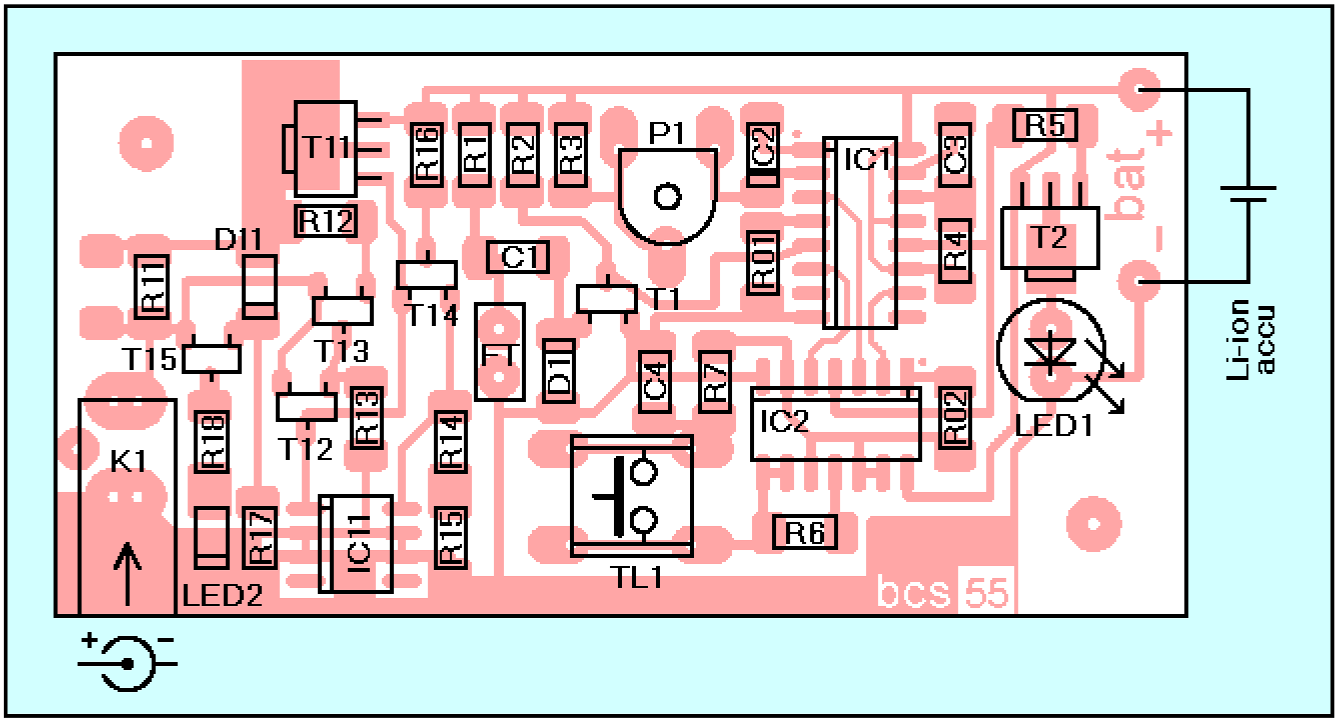


Fig. 4. Layout of lamp components
Fig. 4. Locations of the components on the automatic lamp

Installation and recovery

All the electronic circuits of the lamp are on one printed circuit board. On the plate (**Fig. 3**), apart from the circuit of the lamp of **Fig. 1** , the charger of **Fig**. Only charge the charger components if you want to recharge the Li-ion or Li-pol battery. To charge NiCd, NiMH and alkaline batteries, the charger is not suitable! The board is mostly made of SMD components. On the opposite side of the board is fitted LED1, trim P1, phototransistor, button and charging connector. Only these components can be attached to the connector at the connector. In the SMD version, the C2 capacitor only fits tightly on the board. Instead, use a subminiature electrolytic capacitor located horizontally on the other side of the board. You can boot the photo-transistor from, for example, an old computer mouse. A charger for Nokia phones can be inserted into the 3.8 x 1 mm connector.

Refreshing the lamp is easy, everything should work on the first connection. With the P1 trimmer set the desired lighting time, check the output voltage for the charger, which should be 4.15 to 4.2 V. If the device does not work, compare the logic signals in the function description circuit.

Since I did not have time to produce a box, I placed the flashlight in an emergency box on the parts that are sold in GM Electronic. The component plate is bolted to the transparent lid of the box over 8 mm spacers. There is a battery and a "carry" battery switch in the box that can turn the lamp off completely to prevent it from being switched on or off by accidentally turning on the bag in the bag. The design of the lamp is in the photograph, I believe you can make it more transparent.

Fig. 5. Built-in lamp sample
Fig. 5. Outside view

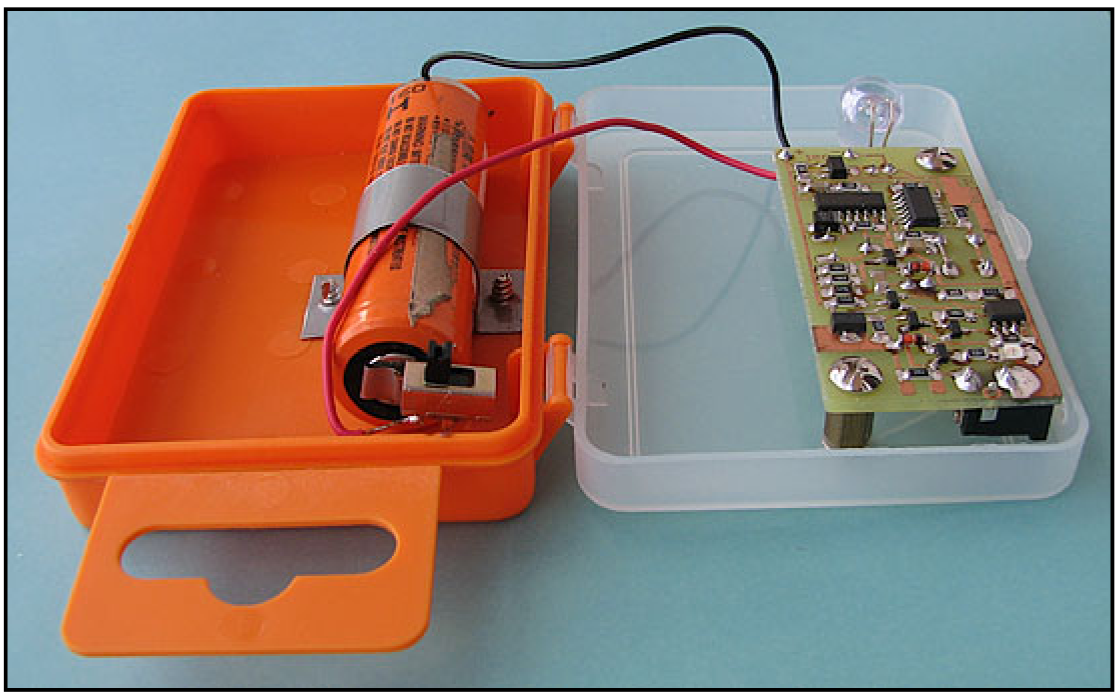


Fig. 6. The inside of the lamp
Fig. 6. Inside view

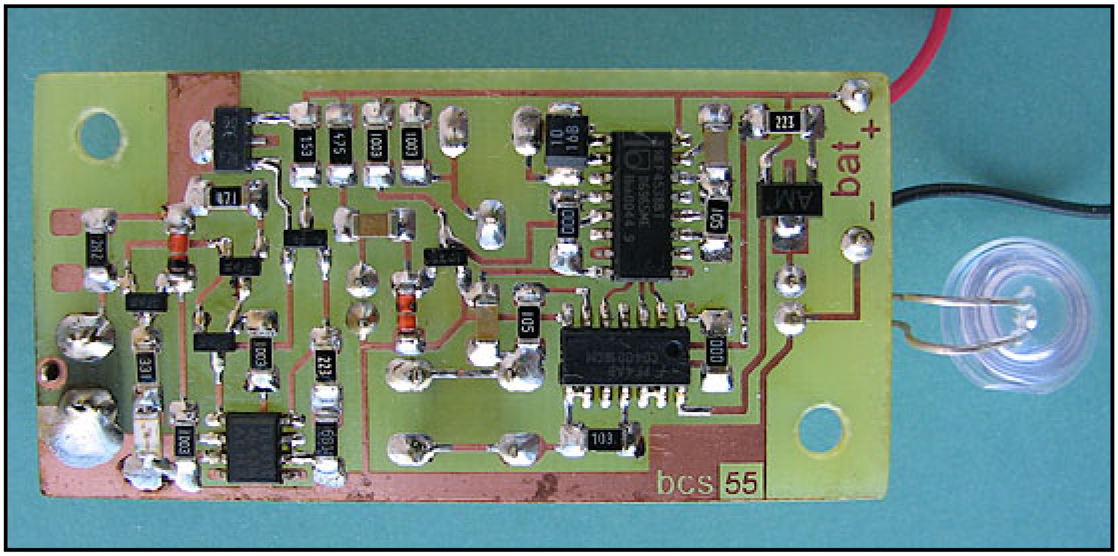


Fig. 7. Plate with pl. joint
Fig. 7. PCB view

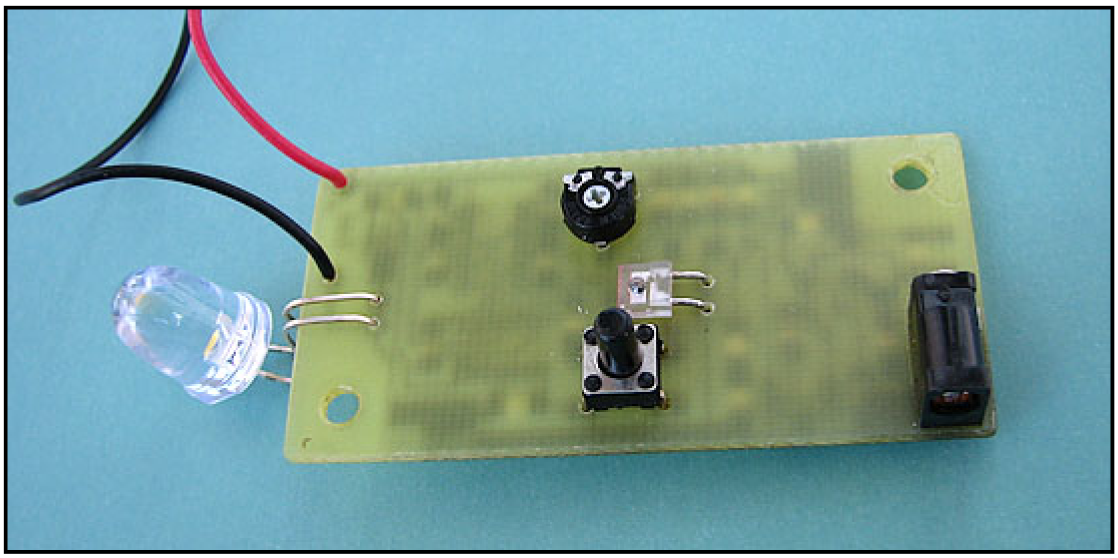


Fig. 8. Built-in lamp sample
Fig. 8. Top side view

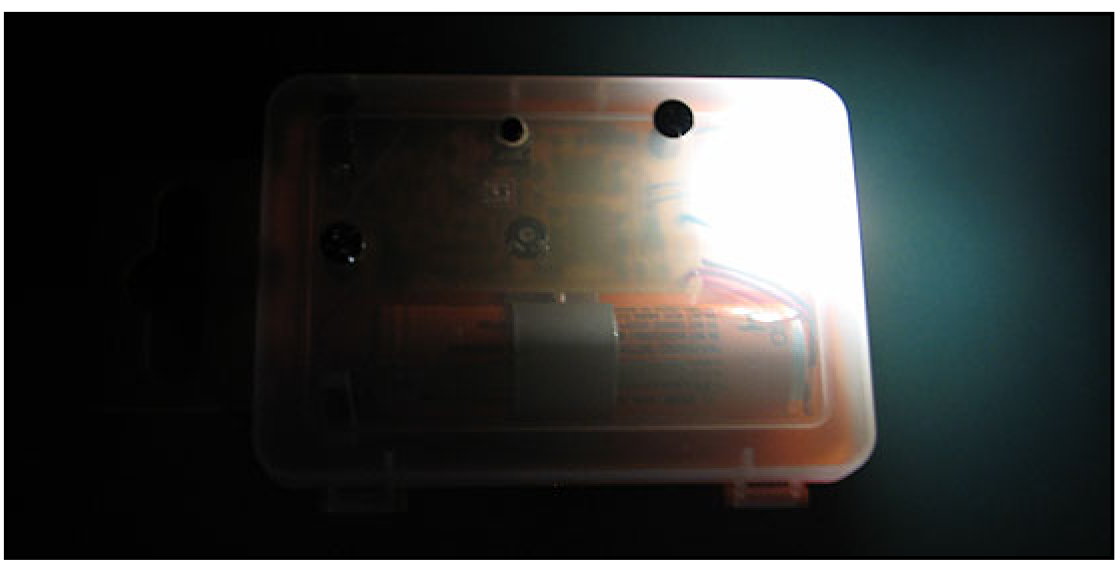


Fig. 9. That's how it shines in the dark
Fig. 9. Dark view

List of parts

lamp			charger	
R01, R02	0 Ohm, jumper (not in diagram)		R11	2.2 Ohm, SMD 1206 (for 230 mA current)
R1	4.7 MOhm, SMD1206		R12	470 Ohm, SMD 1206
R2, R3	100 kOhm, SMD 1206		R13, R17	100 kOhm, SMD 1206
R4, R7	1 MOhm, SMD 1206		R14	22 kOhm, SMD 1206
R5	22 kOhm, SMD 1206		R15	680 Ohm, SMD 1206
R6	10 kOhm, SMD 1206		R16	15 kOhm, SMD 1206
P1	2.5 MOhm, Trim PT6V		R18	330 ohm, SMD 1206
NO. 1	22 nF, SMD 1206		LED2	red (orange) SMD 1206
C2	10 microF / 16 V, SMD A tantalum.		T11	BCX54-16 (BD code)
C3, C4	100 nF, SMD		T12, T13, T15 B	C857 (code 3F)
D1	1N4148, SMD SOD80		T14	BSS138 (SS or J15 code)
LED1	white with high luminosity		IC11	TL431C, SMD SO8
FT	phototransistor L-NP-3C1, see text		K1	socket 3.8 x 1 mm
T1	BC848C (code 1L)			
T2	BCX52-16 (AM code)			
IC1	4538 SMD SO16			
IC2	4001 SMD SO14			
TL1	P-B1720C			
circuit board bcs55				

Appendix

Figure 10 shows the wiring of the lamp without a switch in case it is not needed. The lamp responds only to the "sudden darkness".

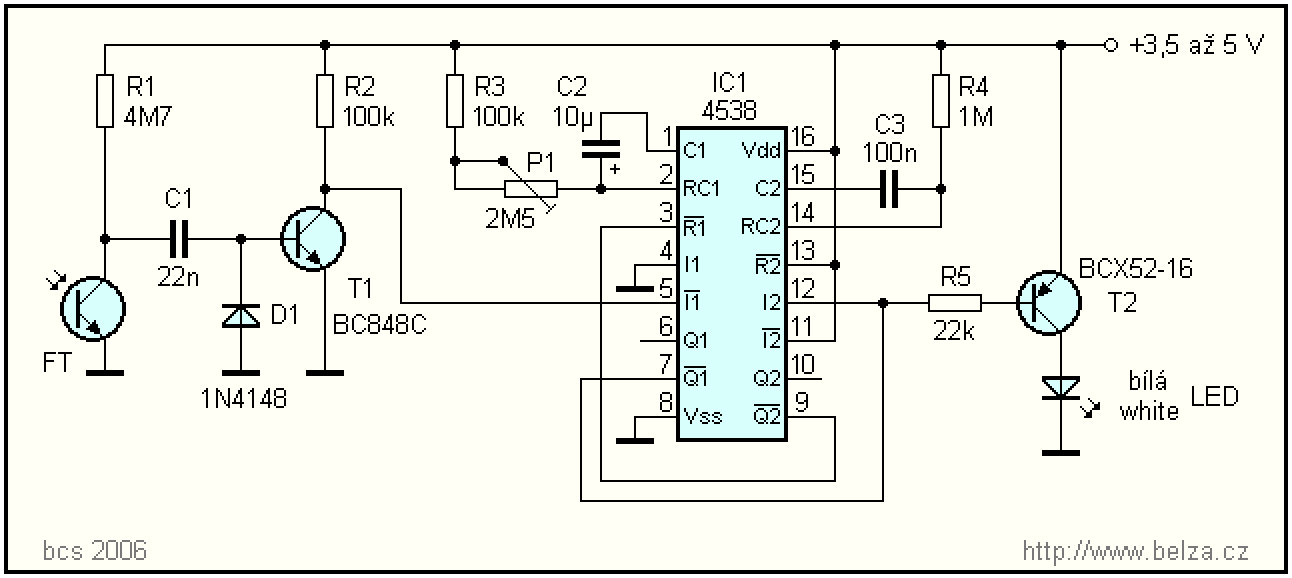


Fig. 10. Connecting the lamp without a switch

Fig. 10. Automatic lamp circuit without On / Auto switch

Jaroslav Belza

The label was printed in PE 5/2006 at page 27

2. 6. 2006

Battery tester

Battery tester

Tester was designed to test the primary (zinc, alkaline) cell. It contains a simple voltage converter and level indicator. Tester is powered from tested cell. Supply current is dependent on cell voltage and at 1.5 V is approx. 200 mA. For high efficiency voltage conversion must be a low saturation voltage transistor T1 used. The tester has a polarity tolerant input (max. 3 V).

The device serves for quick orientation of the feed cells. I built it for my children to be able to determine separately the degree of discharge of batteries in different toys.

Description involvement

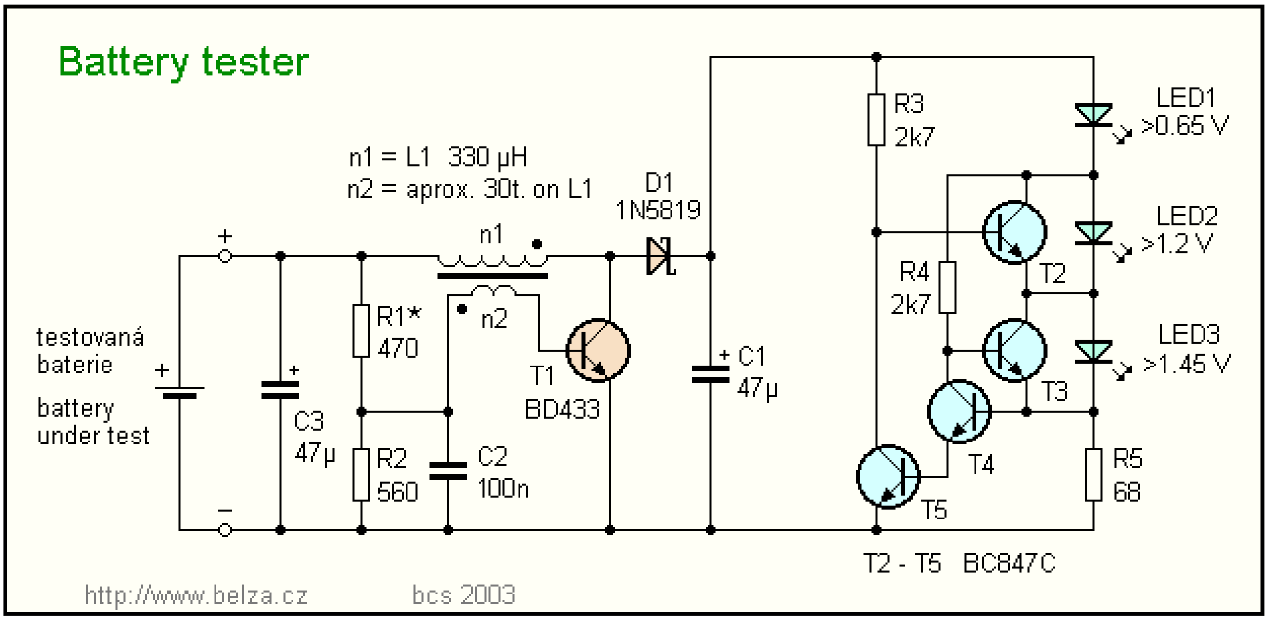


Fig. 1. Connecting the Battery Tester
Fig. 1. Battery tester circuit

The tester is powered from a measuring cell that loads up to 200 mA. It distinguishes the "fresh" article from the old one, which has enough free-circuit voltage, but also a great internal resistance. The maximum input voltage is 3 V, the tester is resistant to reverse polarity. The tester is designed for primary cells. When measuring NiCd and NiMH accumulators, the maximum LED2 is lit due to lower voltage. In the case of accumulators, the voltage drops too slowly during discharge and the tester can only be checked if the battery is not fully discharged.

To test the articles, it would be possible to use a tester - "pincers" with a bulb, but such an amateur electronics solution would hardly satisfy. The tester described here indicates the battery status by the number of LEDs lit. In the connection of the tester (**Fig**), two parts can be distinguished: the voltage converter and the voltage level indicator. Since the LED needs a supply voltage of about 2 volts and the fresh battery is only about 1.55 volts, it is necessary to use the drive in the wiring. The inverter is self-deceiving and uncontrolled, the output voltage is highly dependent on input voltage. This dependence is deliberately magnified by using the R1, R2 dividers in the base circuit. A critical part of the inverter is the transistor T1, which must have a low saturation voltage. Otherwise, efficiency is rapidly deteriorating. A conventional radial choke is used as a transformer, to which we turn on a secondary winding - about 30 threads with a wire of about 0.2 mm in diameter. We pull the shrink sleeve over the winding and the transformer is finished. The embodiment of the coil is evident from the photograph in **FIG. 2** .

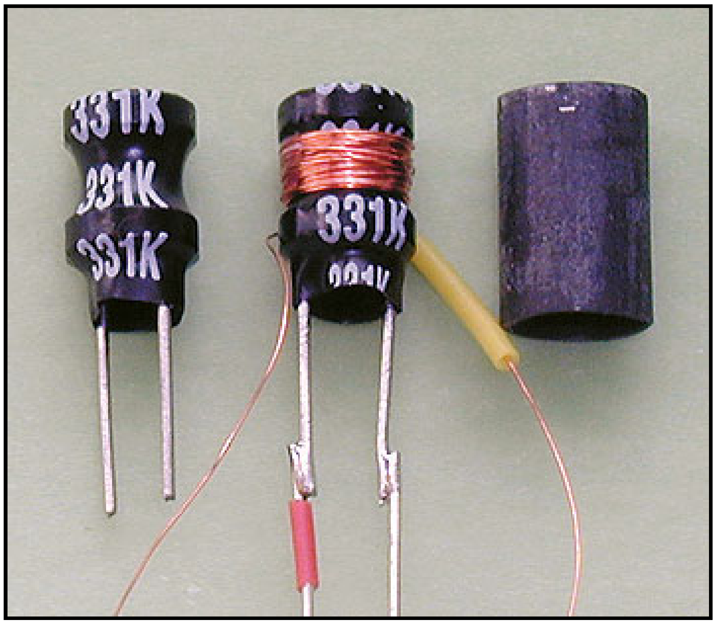


Fig. 2. Manufacture of transformer
Fig. 2. Secondary coil transformer winding

The second part is the voltage indicator. At low voltage, transistors T2 and T3 are open via resistors R3 and R4, transistors T4 and T5 are closed. If the voltage increases, the LED1 will first illuminate. Upon further increase of the voltage, the LED current increases until the voltage drops to R5 does not open T5 (about 16 mA). Transistor T2 closes and voltage on LED2 increases as long as it starts to light up. If the supply voltage continues to increase, the T4 opens at a current of about 20 mA. Transistor T3 closes and LED3 lights up. At even higher voltages, the current is no longer limited to the stand alone indicator, but the tester is limited by the drive power. The power of the inverter and thus the input voltage at which the LED3 lights up can be partly influenced by the change of resistance R1.

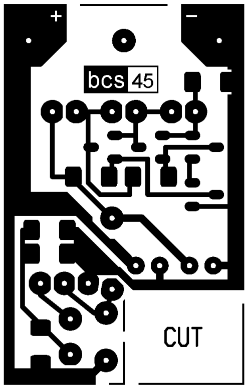


Fig. 3. Tester circuit board. If you use the right mouse button and choose Save Image As, you will get a link template at 600 dpi (16 KB)
Fig. 3. PCB layout battery tester. Click the right mouse button and choose "Save image as" to get 600 dpi resolution image (16 kB)

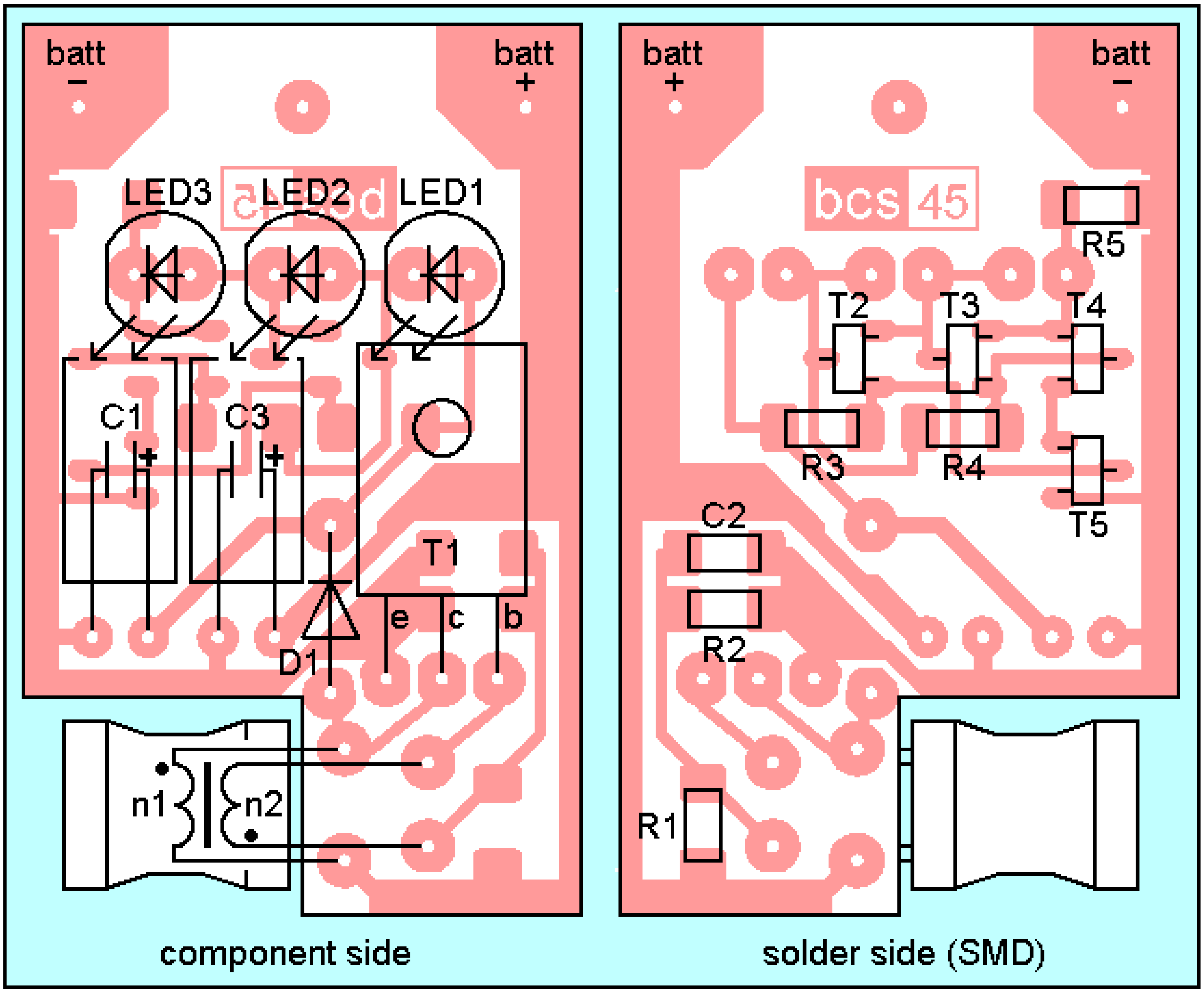


Fig. 4. Layout of the components on the board
Fig. 4. Locations of components on board

I built the tester into a small box of KP32, which is also customized with the design of a printed circuit board, which is partly fitted with SMD components. The spool is horizontal for dimensional reasons. For the LED, first drill holes in the box, then place the LED board in the box and then light the LED into the board. I stuck the rear lid of the box with the hot melt glue on the animated tester. Placing such a small board is harder, but it does not prevent you from designing your own board, fitted with classical components, or using a piece of universal board.

Revival

It is best to use a controllable power supply, you also need a universal measuring device, just the simplest multimeter. Connect the tester to the power supply and slowly increase the supply voltage from zero to about 1.6 volts. After mounting the board, the tester can work on the first attempt, but Murphy's law is very likely to n2 winding poorly. The polarity of the winding can only be detected in advance. Therefore, if the inverter does not oscillate, taking the tester to withdraw the current, first replace the winding ends n2. If even after this intervention the tester did not work, brighten up its individual parts.

First connect the power supply to the capacitor C1 and slowly increase the voltage. At about 3 volts, the LED1 lights up at about 5.5 V of LED2 and at 8 V and LED3. The power supply should not exceed 20 mA until LED3 lights up. If the indicator does not work as described, there will be an error in it.

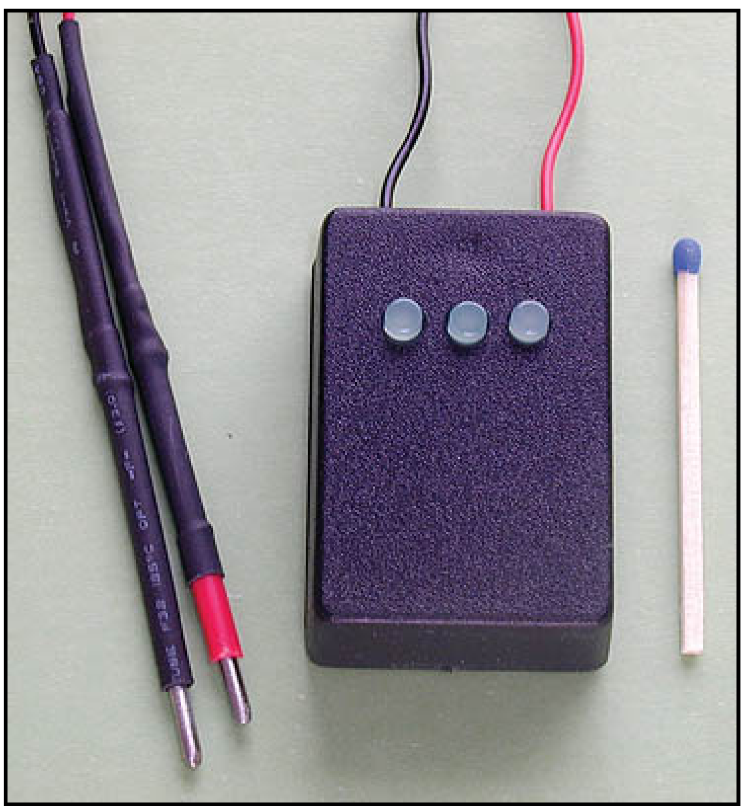
If the indicator is OK, check the inverter. If the supply voltage is increased from 0 to 1.6 V, the voltage should gradually rise up to 8 V at C1. If the coil secondary coil outlets do not work, the T1 or diode may be

defective.

It can also happen that the tester works, but at 1.5 V does not give enough power to turn on all LEDs. Then you can carefully change the resistance of resistor R1. If it does not help, it is still possible to increase the resistance of R5. Turning on all the LEDs will be enough to supply the less current.

List of parts

R1	470 Ohm, SMD1206
R2	560 Ohm, SMD 1206
R3, R4	2.7 kOhm, SMD 1206
R5	68 Ohm, SMD 1206
C1, C3	47 µF / 10 V
C2	100 nF, SMD 1206
L1	330 µH, choke 09P
D1	1N5819, Schottky 1 A
T1	BD433
T2 - T5	BC857C, SMD
LED1 - LED3	green standard LED (2 V / 20 mA) standard green
about 1 m of paint. wire dia. 0.1 to 0.25 mm for winding n2 approx. 3 ft AWG No.33 (30 to 36) wire for n2 winding	
shrink sleeve, lead wires, measuring tips	
box / box	KP32
printed circuit board / PCB No.	bcs45



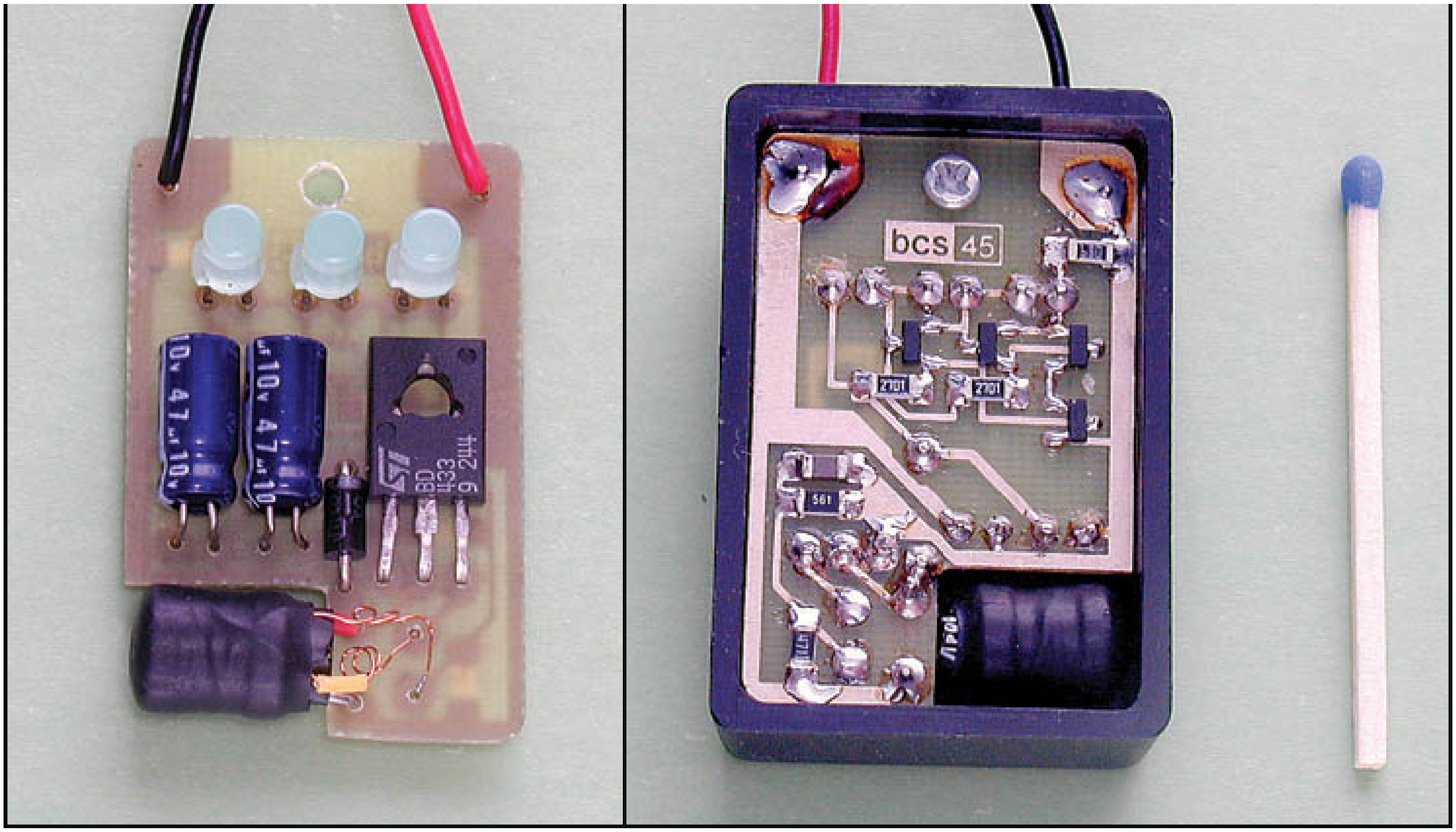


Fig. 5, 6, 7. Photograph of external and internal tester

Fig. 5, 6, 7. Exterior and interior view

Jaroslav Belza

The tester was published in Practical Electronics No. 7/03 on p. 22 under the title "Tester of Articles".

August 2, 2003

Cable, Wiring and Connector Guide

Your reference guide for PCB (trace resistivity, footprint) wire (gaage chart), mil/ inch/mm, hole (drill, tap chart), fastener

Edited by Lim Siong Boon, last dated 02-Oct-09.

email: mail@siongboon.com
website: http://www.siongboon.com

Shortcut to your reference guides and charts

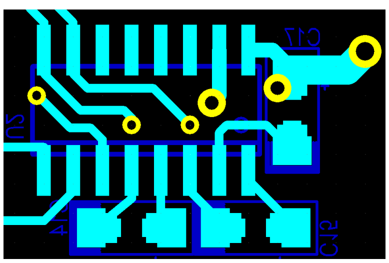
1. PCB Trace reference
2. Wire and Cable gauge
3. Advance conductor
4. PCB Footprint reference
5. Tap drilling guide (mm chart)
6. Common Connector Pin Out
7. Name of Connectors/Plugs
8. Name of Cable/Wire

I always have to refer to these dimension references frequently,

and decide to put them up once and for all on this website.

Hope they are useful to you too.

1. PCB Trace reference



Trace resistance guide based on
PCB board 1oz copper at temperature 100˚C. (worst case)

Name	Trace width	Trace Length	Resistance	Current
Power Normal	1.27mm	1000mm	0.49Ω	1.75A
Power Min	0.64mm	1000mm	0.98Ω	1.20A
Signal Normal	0.38mm	1000mm	1.65Ω	0.80A
Signal Min	0.25mm	1000mm	2.51Ω	0.50A
	mm	mm	Ω	

Conversion calculator might not work on some web browser.

Unit conversion table & calculator between inch, mil, mm, oz.

inch	mil	mm	oz
1	1000	25.4	
0.1	100	2.54	
0.001	1	0.0254	
0.03937	39.37	1	
	1.38	0.035	1oz
inch	mil	mm	oz

The IC chips, active and passive components are all connected by traces or wire. The traces on the PCB are assume to be of short circuit, which is 0Ω. This assumption is reasonable if it conduct a very small amount of current. When the conductor starts to carry larger amount of current, the voltage drop across the trace could be significant, causing intermediate hardware problem.

If you are expecting a large current flowing through the traces, you have to keep in mind to provide a wider trace to increase the conductivity of the cable. Larger trace width means lower resistance.

For my PCB route software, the defined trace width for power is 1.27mm and signal is 0.38mm. Sometimes there is a need to route the trace through narrow space. In this situation, I would have to use the recommended trace width for power min, and signal min. Usually I will keep this narrow trace as short as possible to avoid higher resistance.

Seldom do I need to worry about traces carrying signal information. I am more worried about the conductor distributing the dc supply to individual circuit zone. Whenever possible, I would provide a wider traces for my 5V and ground supply.

When designing the PCB routing for my power supply, I would use the star topologies. This will ensure a evenly spread for the current distribution, hence lowering the burden of individual traces. I have actually experience such technical issue during my final year school project. The noise problem is somehow reduce after the attempt to improve on the trace routing. Another experience involve power up a remote system about 10m away. The distance is quite near and the power cable is rather thick to me. The voltage at the remote end is found to be too low to power the remote system. We have to double the cable conductor in order to resolved the problem. Our equipment conduct high current of about 20A if I remember correctly. The problem might not be obvious because the high current being drawn might happen during certain hard to determine event. For example, when your system trigger the lightings or motor which draws very high current for a short period of time. The voltage drop cause by the sudden high current draw might cause your system to fail. Therefore the design should always cater for the worst case. Always find out the maximum possible current drawn. Over design the system to ensure that the system will not fail in the worst case scenario. Just to make a note, that I have been referring to dc voltage supply.

Conversion calculator might not work on some web browser.

also Download the [wire gauge calculator] from UltraCAD Design, Inc

For high voltage AC supply, I guess it is a different way of looking at it. My understanding in high voltage system is quite weak.

On the left is the reference table to estimate the resistance of the trace for my PCB routing. I have assume the worst case at temperature 100˚C with the copper layer of 1oz thick. Seldom do you need to refer to this table, unless you have encounter space restriction for your high current carrying traces. It is my usual practise to double the current carrying capacity. 2 times the maximum current I will be expecting. If you have the space, make it wider.

Electrical Resistance Equations:

Resistance = Resistivity x Length/Area

Question 1:
1oz copper PCB, Trace width 0.25mm, Trace length 0.1m, Operating temperature 25˚C

Solution 1:
Copper resistivity at 25˚C is $1.68 \times 10^{-8} \Omega.m$

Resistance $= 1.7 \times 10^{-8} \Omega.m \times 0.1m \,/\, (1oz \times 0.25mm)$
$= 1.7 \times 10^{-8} \Omega.m \times 0.1m \,/\, (35um \times 0.25mm)$
$= 1.7 \times 10^{-8} \Omega.m \times 0.1m \,/\, (8.75nm^2)$
$= 1.7 \times 10^{-8} \Omega.m \times 0.0114 \times 10^{9} m^{-1}$
$= \underline{0.19\Omega}$

Question 2:
1oz copper PCB, Trace width 0.25mm, Trace length 0.1m, Operating temperature 100˚C

Solution 2:
Copper resistivity at 100˚C is $2.17 \times 10^{-8} \Omega.m$,

Resistance $= 2.2 \times 10^{-8} \Omega.m \times 0.1m \,/\, (1oz \times 0.25mm)$
$= 2.2 \times 10^{-8} \Omega.m \times 0.0114 \times 10^{9} m^{-1}$
$= \underline{0.25\Omega}$

I have also provide the computation for copper resistance for your reference. Taking this opportunity to do further read up in order to explain in a simplified form.

Area is the cross sectional area of the conductor. Just like a water pipe, the larger the cross sectional area, the easier the current is able to flow through.

Resistivity defines the resistance of the material for a unit of length at a certain temperature. The resistivity for the material copper at 25˚C is found to be $\underline{1.7 \times 10^{-8} \Omega.m}$

The resistivity changes with temperature. The resistance will increase as the temperature increase. The term for this changing resistivity with temperature is known as the thermal resistivity of that particular material.

The material resistivity would therefore look like a graph curve. They are obtained through test and experiment. For some material, the graph curve could be approximated in the form of equation. This complicated formula describe the resistance behavior of the material under different temperature condition. For copper material, it can be represented from the following equation,

Copper resistivity $= \rho_0(1+\alpha(\text{Temperature}-T_0))$

$= 1.7 \times 10^{-8} \Omega.m \times (1 + 3.9 \times 10^{-3} \Omega/˚C \times (100˚C-25˚C))$

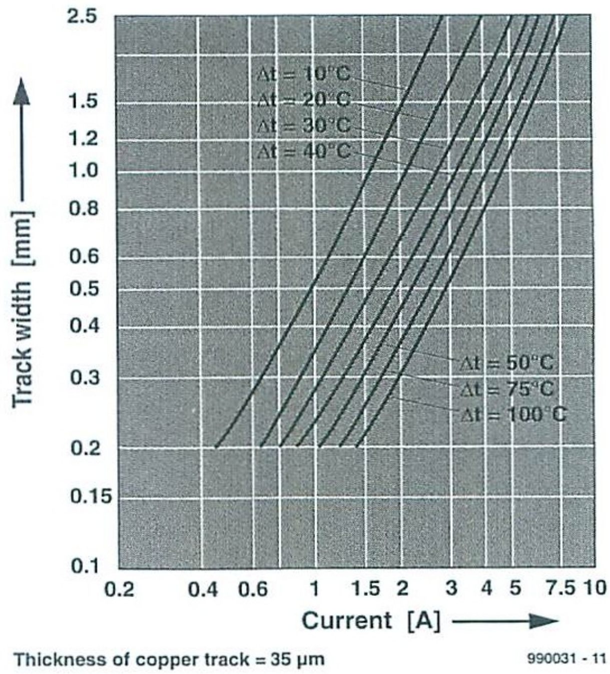
$= \underline{2.2 \times 10^{-8} \Omega.m}$ at a temperature of 100˚C

<ρ_0 is the material resistivity at T_0 temperature>

As you can see from the calculation on the left, the increase in temperature from 25˚C to 100˚C has increase the 0.1m copper trace by 0.06Ω. This is about 30% increase in the resistance.

To keep the topic simple, we will not go into the details of varying temperature. There can be other factor that can affect the resistance of the material.

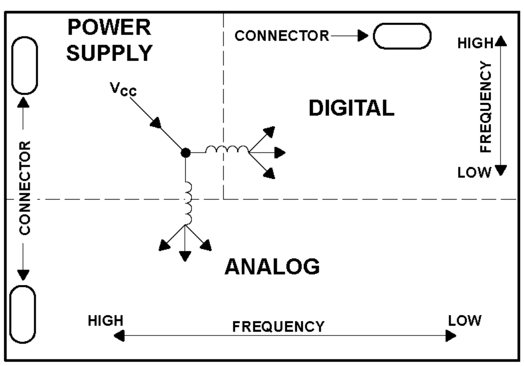
Here is a quick and simple graph showing the change in temperature in relation with the trace width and the current flowing through it. (taken from the magazine elektor 2010-02). The graph assume the pcb copper trace thickness to be 35um (1oz) & that it is place in a open air environment (not enclosed inside a box/casing). For example, given the trace width of 0.6mm, and a 1.5A current flowing through it, we can expect the copper area to rise by another 10°C.



Some article reference:

[PCB trace - HwB, trace vs current graph.pdf]

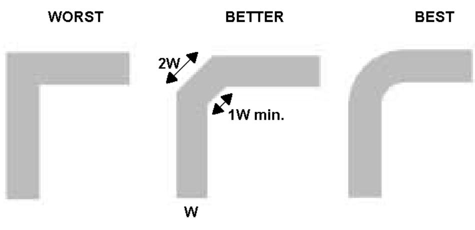
Recommended digital and analog circuit layout on a PCB board.



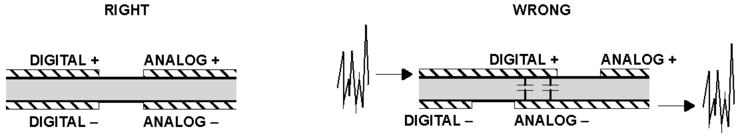
Reference taken from "[Op Amps for Everyone]".

More PCB layout recommendation can be found in the book "[Op Amps for Everyone]" from Texas Instruments.

Recommended trace corner layout.



Recommended plane placement.



2. Wire and Cable gauge

I have put up this wire gauge guide for my own reference. Very often there is a need to return to this reference to choose an appropriate cable for use. I have also written an article some time back. Myth about how the cable relate to their resistance. It is taken out from the main webpage but I have place a link here, for anyone who are interested to understand more.

NOTE: The following guideline is a brief guideline for **copper ampacity (current rating** or **current-carrying capacity)** of the cable used for power supplying purpose. The ampacity is defined as the maximum current the cable can withstand. Any current higher than that will generate enough heat to burn away the cable. There are many factor affecting the current capacity of the cable, and it should be compensated accordingly. I would advise to select the cable, with at least double the current-carrying capacity for the intended equipment. Never operate near the cable current-capacity limits. You will never know when, the current overruns. Some of the factors that will affect the current-carrying capacity of a cable are:

- Conductive wire cross section area.
- Wire material. The temperature the material can withstand without melting out.
- Temperature. If the wire/insulator jacket can withstand higher temperature, the cable is able to carry more current.
  - place of installation or the surrounding temperature.
  - material of insulation jacket/skin/cover.
  - how much the cable can dissipate heat
- Stranded or solid wire type. Stranded wire can carry more current than a solid wire for AC type of signal/power. This is due to a phenomenon known as skin effect.

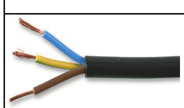
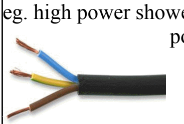
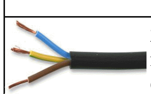
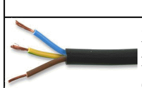
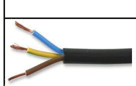
Reference:
- ayenbee AWG Wire Current Rating guide.pdf
- Wire Chart for 12Volt 24Volt.pdf
- A Guide to Wire and Cable Construction.pdf

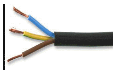
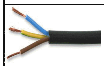
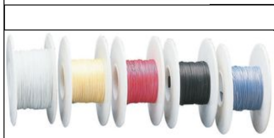
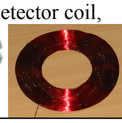
230v Cable Size Selector- http://www.electacourse.com/cableselector.html

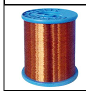
The factors involve are quite complex. The table is a simplified reference for myself to select the cables. Always allow a larger safety margin of minimum x2 when you chose your cable. Do take careful note of what you deploy.? There are many other factor, eg screw connections, plug contact which will affects the results. If the cable has the slightest warm, it is quite clear that the cable will be hitting it's limit any time soon.

AWG CONTRAST LIST

AWG	external diameter 公制mm	英制inch	截面积 (mm2)	电阻值 (W/km)	AWG	external diameter 公制mm	英制inch	截面积 (mm2)	电阻值 (W/km)
4/0	11.68	0.46	107.22	0.17	22	0.643	0.0253	0.3247	54.3
3/0	10.40	0.4096	85.01	0.21	23	0.574	0.0226	0.2588	48.5
2/0	9.27	0.3648	67.43	0.26	24	0.511	0.0201	0.2047	89.4
1/0	8.25	0.3249	53.49	0.33	25	0.44	0.0179	0.1624	79.6
1	7.35	0.2893	42.41	0.42	26	0.404	0.0159	0.1281	143
2	6.54	0.2576	33.62	0.53	27	0.361	0.0142	0.1021	128
3	5.83	0.2294	26.67	0.66	28	0.32	0.0126	0.0804	227
4	5.19	0.2043	21.15	0.84	29	0.287	0.0113	0.0647	289
5	4.62	0.1819	16.77	1.06	30	0.254	0.0100	0.0507	361
6	4.11	0.1620	13.30	1.33	31	0.226	0.0089	0.0401	321
7	3.67	0.1443	10.55	1.68	32	0.203	0.0080	0.0316	583
8	3.26	0.1285	8.37	2.11	33	0.18	0.0071	0.0255	944
9	2.91	0.1144	6.63	2.67	34	0.16	0.0063	0.0201	956
10	2.59	0.1019	5.26	3.36	35	0.142	0.0056	0.0169	1,200
11	2.30	0.0907	4.17	4.24	36	0.127	0.0050	0.0127	1,530
12	2.05	0.0808	3.332	5.31	37	0.114	0.0045	0.0098	1,377
13	1.82	0.0720	2.627	6.69	38	0.102	0.0040	0.0081	2,400
14	1.63	0.0641	2.075	8.45	39	0.089	0.0035	0.0062	2,100
15	1.45	0.0571	1.646	10.6	40	0.079	0.0031	0.0049	4,080
16	1.29	0.0508	1.318	13.5	41	0.071	0.0028	0.0040	3,685
17	1.15	0.0453	1.026	16.3	42	0.064	0.0025	0.0032	6,300
18	1.02	0.0403	0.8107	21.4	43	0.056	0.0022	0.0025	5,544
19	0.912	0.0359	0.5667	26.9	44	0.051	0.0020	0.0020	10,200
20	0.813	0.0320	0.5189	33.9	45	0.046	0.0018	0.0016	9,180
21	0.724	0.0285	0.4116	42.7	46	0.041	0.0016	0.0013	16,300

Wire Cable Description	Diameter (mm)	Area (mm^2)	Copper Resistance 20°C.Ω/km	Nearest SWG gauge (mm)	Nearest AWG gauge (mm)
	11.68	107.2	-	-	0000
	10.4	85.03	-	-	000
	9.266	67.43	-	-	00
	8.252	53.48	-	-	0
	7.348	42.41	-	-	1
	6.543	33.63	-	-	2
	5.827	26.27	-	-	3
	5.189	21.15	-	-	4
 230Vac power cable 16mm^2 (absolute maximum 69A) eg. Sub Mains	4.620	16.77	-	-	5
	4.115	13.30	-	-	6
230Vac power cable 10mm^2 (absolute maximum 52A) eg. high power showers, cookers & other very high power devices 	3.665	10.55	-	-	7
	3.264	8.366	-	-	8
 230Vac power cable 6mm^2 (absolute maximum 38A) eg. showers, cookers & other high power devices	2.906	6.634	-	-	9
	2.588	5.261	-	-	10
 230Vac power cable 4mm^2 (absolute maximum 30A, 6.9kW) eg. low power electric shower	2.305	4.172	-	-	11
	2.00	3.10	**5.47**	14 (2.05)	12 (2.05)
	1.90	2.80	**6.05**		
 230Vac power cable 2.5mm^2 (absolute maximum 23A)	1.80	2.60	**6.76**	15 (1.83)	13 (1.83)
	1.70	2.30	**7.57**		
 Wire copper enameled, Pro-Power ECW1.5. current rating 2.74A eg. power speaker, transformer, motor	1.60	2.00	**8.54**	16 (1.63)	14 (1.63)
	1.50	1.80	**9.7**		

 230Vac power cable 1.5mm^2 (absolute maximum 16A, 3.6kW)	1.40	1.50	**11.2**	17 (1.42)	15 (1.45)
	1.30	1.30	**13.0**		16 (1.29)
 230Vac power cable 1mm^2 (absolute maximum 13A, 2.99kW) eg. for light circuit	1.20	1.10	**15.2**	18 (1.22)	
	1.10	0.95	**18.1**		17 (1.15)
 Audio cable (shielded), Belden 8760 eg. power speaker drive	1.00	0.78	**21.1**	19 (1.02)	18 (1.02)
	0.95	0.71	**24.3**		
	0.90	0.64	**26.9**	20 (0.91)	19 (0.91)
	0.85	0.57	**30.2**		
	0.80	0.50	**34.1**	21 (0.81)	20 (0.81)
	0.75	0.44	**38.9**		
	0.70	0.69	**44.6**	22 (0.71)	21 (0.72)
	0.65	0.33	**51.7**		22 (0.64)
	0.60	0.28	**60.7**	23 (0.61)	
	0.55	0.24	**72.3**	24 (0.56)	23 (0.57)
Wire Cable Description	**Diameter (mm)**	**Area (mm^2)**	**Copper Resistance 20°C.Ω/km**	**Nearest SWG gauge (mm)**	**Nearest AWG gauge (mm)**
 Category 5E network cable, 8060-OZZ7FNL from Alcatel  16 strand Ø0.2mm/strand  Multipurpose 10core shielded. (RS232 communication, data signal), Belden 9540, Belden 9536 (6 core), Belden 9534 (4 core)	0.50	0.20	**87.5**	25 (0.51)	24 (0.51)
 Category 5E network cable	0.45	0.16	**108**	26 (0.46)	25 (0.45)
 Telephone line cable, GC5040 from Pro Power	0.40	0.13	**137**		26 (0.40)
	0.35	0.096	**178**	29 (0.35)	27 (0.36)
 Ribbon cable, 1.27mm pitch					28
	0.30	0.071	**243**	31 (0.29)	29 (0.28)
 Wire wrapping wire, Ok Industries	0.25	0.049	**351**	33 (0.25)	30 (0.25)
 Wire copper enameled eg. small magnetic coil, speaker, solenoid, inductor, metal detector coil, small motor.  	0.20	0.031	**547**		32 (0.20)
	0.19	0.028	**605**	36 (0.19)	
	0.18	0.026	**676**		33 (0.18)
	0.17	0.023	**757**	37 (0.17)	
	0.16	0.020	**844**		34 (0.16)
	0.15	0.018	**970**	38 (0.15)	
	0.14	0.015	**1120**		35 (0.14)
	0.13	0.013	**1300**	39 (0.13)	36 (0.13)
	0.12	0.011	**1520**	40 (0.12)	
	0.11	0.0095	**1810**	41 (0.11)	37 (0.11)
	0.10	0.0078	**2190**	42 (0.10)	38 (0.10)
	0.09	0.0064	**2700**	43 (0.09)	39 (0.09)
	0.08	0.0050	**3420**	44 (0.08)	40 (0.08)
	0.07	0.0039	**4460**	45 (0.07)	41 (0.07)

	0.06	0.0025	**6070**	46 (0.06)	42 (0.06)
 Wire copper enameled (very fine) eg. transformer coupler for audio/signal, wire for earphone	0.05	0.0020	**8750**	47 (0.05)	43 (0.05)
Wire Cable Description	**Diameter (mm)**	**Area (mm^2)**	**Copper Resistance 20˚C.Ω/km**	**Nearest SWG gauge (mm)**	**Nearest AWG gauge (mm)**

Cable Guide (typical cable type and name) [Click the chart for enlarge view.]

Chart and images taken from Farnell, RS components and other websites.

also Download the wire gauge calculator from UltraCAD Design, Inc

Other reference,

http://www.wiki.diyfaq.org.uk/index.php?title=Cables#Cable_Sizes

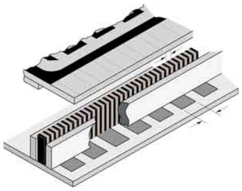
Refer to the most current National Electrical Code for further information on the electrical cable standards.

3. Advance conductor

Special material for conductivity connection. Some references for non-traditional or advance conductor materials.

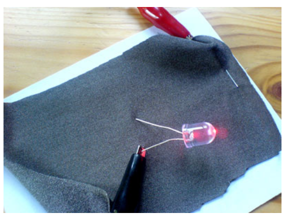
I happen to see some special wire product that I think I should put them in this website for reference.

The follow shows a rubber strip (a black layer sandwich in between the two white layer). It is call the elastomer connector. It is typically used to connect a flat LCD display panel to the pcb board without any soldering. It is quite cool when it was being shown to me for the first time. The LCD and pcb is connected with this elastomer connector sandwich in between.



Elastomer connector
(soft rubber strip that can conduct like a wire)

Conductive fabric or cloth



this pic is tken from other website

The conductive fabric actually can feels like a typical cotton cloth material. Some other feels like a nylon fabric, a bit like plastic. This is great for RF shielding, which we used it to test the performance of RF transmission through various material.

REDTEC INDUSTRIES PTE. LTD. 瑞德工业有限公司

Polymer Technologies Pte. Ltd.

Glocom Marketing Pte Ltd

Conductive glass

reference: conductive glass

Singapore Safety Glass

Conductive paint

Conductive tapes

4. PCB Footprint reference

[Click here to access to footprint page.](#)

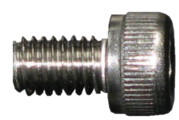
5. Tap drill guide (metric chart)

Commonly used screw size in Singapore, Metric (fine pitch)

Screw Standard	Screw diameter 'O'	Drill size diameter 'I'	Pitch (fine)
M1	1.0mm	0.75mm	
M1.1	1.1mm	0.85mm	
M1.2	1.2mm	0.95mm	
M1.4	1.4mm	1.10mm	
M1.6	1.6mm	1.25mm	
M1.8	1.8mm	1.45mm	
M2	2.0mm	1.60mm	
M2.2	2.2mm	1.75mm	
M2.5	2.5mm	2.05mm	
M3	3.0mm	**2.50mm**	0.35mm
M3.5	3.5mm	2.90mm	
M4	4.0mm	**3.20mm**	0.5mm
M4.5	4.5mm	3.70mm	
M5	5.0mm	**4.20mm**	0.5mm
M6	6.0mm	**5.00mm**	0.75mm
M7	7.0mm	**6.00mm**	0.75mm
M8	8.0mm	**6.70mm**	1.0mm
M9	9.0mm	7.80mm	
M10	10.0mm	**8.50mm**	1.25mm
M11	11.0mm	9.50mm	
M12	12.0mm	**10.20mm**	1.5mm
M14	14.0mm	12.00mm	
M16	16.0mm	14.00mm	1.5mm
M18	18.0mm	15.50mm	
M20	20.0mm	17.50mm	
M22	22.0mm	19.50mm	
M24	24.0mm	21.00mm	2.0mm
M27	27.0mm	24.00mm	2.0mm
1/4"-36	6.5mm	6.0mm	Thread for SMA RF connector thread
1/4"-36	6.5mm	6.0mm	Toggle switch thread

->

Image of a machine cap screw



Enlarge image of the screw thread

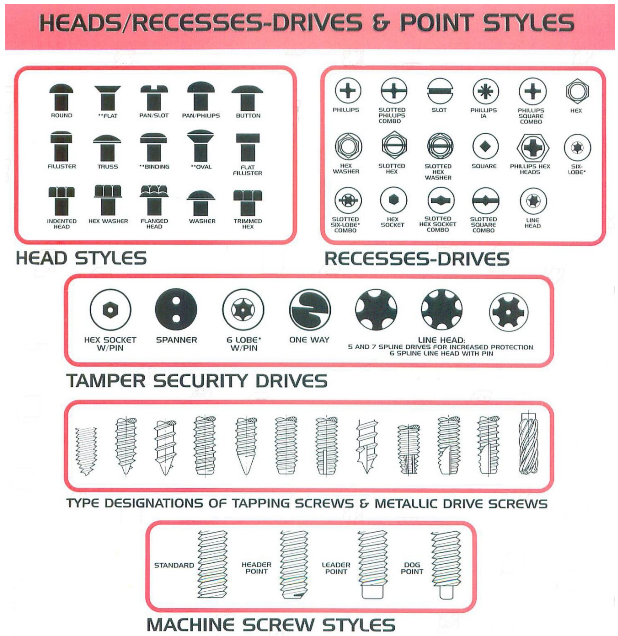
diameter 'I' Diameter of the screw core
(Hole size to drill, for tapping the thread)

diameter 'O' Diameter of the screw thread

Fastener Manufacturer:

References: http://www.aboveboardelectronics.com/catalogsmain.htm

Fasterner selection guide
http://www.aboveboardelectronics.com/abe_prodmain.htm
http://www.boltdepot.com/fastener-information/Type-Chart.aspx



Plastic fastener, Cable accessories

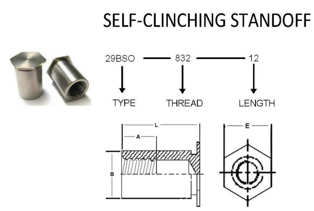
Enclosure bumper/rubber padding

Slide

Self-Clinching Nut, Standoff Guide

Self Clinching Standoff

SELF-CLINCHING STANDOFF



All dimensions are in inches

DIMENSIONS						
	Thread Code	Min Sheet Thickness	Hole Size In Sheet + .003 - .000	C + .000 - .005	H Nom.	Min. Dist Hole C/L To Edge
UNIFIED	440	.040	.166	.165	.187	.23
	6440	.040	.213	.212	.250	.27
	632	.040	.213	.212	.250	.27
	8632	.050	.281	.280	.312	.31
	832	.050	.281	.280	.312	.31
	032	.050	.281	.280	.312	.31

All dimensions are in millimeters

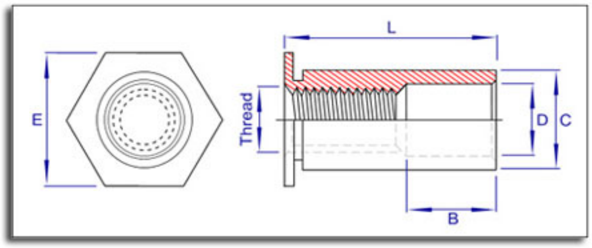
DIMENSIONS						
	Thread Code	Min Sheet Thickness	Hole Size In Sheet + 0.08	C - 0.13	H Nom.	Min. Dist Hole C/L To Edge
METRIC	M3	1.02	4.22	.165	.187	.23
	3.5M3	1.02	5.41	.212	.250	.27
	M3.5	1.02	5.41	.212	.250	.27
	M4	1.27	7.14	.280	.312	.31
	M5	1.27	7.14	.280	.312	.31

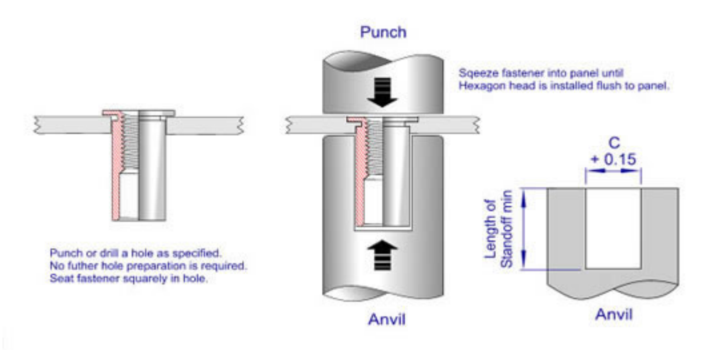
Thor International Company
10 Ubi Crescent #04-46 Singapore 408564 Tel:+65 67434155 Fax:+65 67421106 Email: sales@thorintl.com

DIMENSIONS																		
	Thread Size	Type			Thread Code	Length Code "L" +.002 - .005 Length Code is in 16ths of an inch												
		Steel	Stainless Steel	Aluminium		.312	.375	.438	.500	.562	.625	.687	.750	.812	.875	.937	1.0	1.062
UNIFIED	.112-40 (4-40)	29BSO	29BSOS	29BSOA	440 6440	10	12	14	16	18	20	22	24	26	28	30	32	34
	.138-62 (6-32)	29BSO	29BSOS	29BSOA	632 8632	10	12	14	16	18	20	22	24	26	28	30	32	34
	.164-32	29BSO	29BSOS	29BSOA	832	10	12	14	16	18	20	22	24	26	28	30	32	34
	.190-32	29BSO	29BSOS	29BSOA	032													

DIMENSIONS															
	Thread Size	Type			Thread Code	Length "L" + 0.05 - 0.13 Length Code in millimeters									
		Steel	Stainless Steel	Aluminium											
METRIC	M3x0.5	29BSO	29BSOS	29BSOA	M3 3.5M3	6	8	10	12	14	16	18	20	22	25
	M3.5 x 0.6 M4 x 0.7 M5 x 0.8	29BSO	29BSOS	29BSOA	M3.5 M4 M5	6	8	10	12	14	16	18	20	22	25

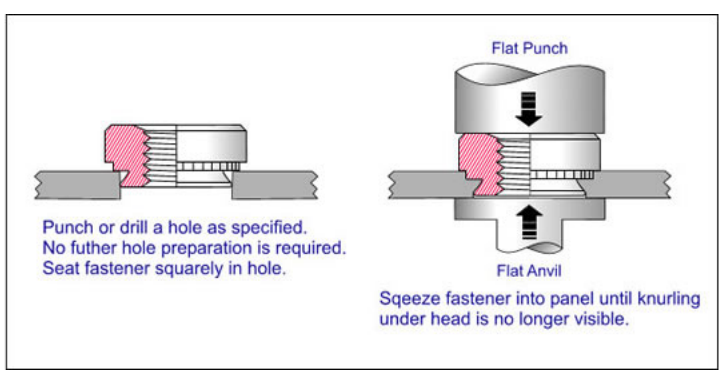
Installation Guide



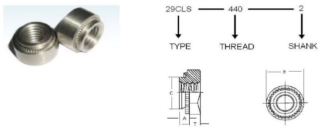


Self Clinching Nut

Installation Guide



SELF-CLINCHING NUT



All dimensions are in inches

	DIMENSIONS												
	Thread Size	Type: Carbon Steel	Type: Stainless Steel	Type: Aluminium	Thread Code	Shank Code	A (Shank) Max.	Min Sheet Thickness	Hole Size in Sheet + .003 - .000	C Max.	E ±.010	T ± .010	Min Dist Hole C/L To Edge
UNIFIED	.086-56 (2-56)	29S	29CLS	29CLA	256	0	.030	.030	.166	.165	.25	.07	.19
						1	.038	.040					
						2	.054	.056					
	.099-56 (3-48)	29S	29CLS	29CLA	348	0	.030	.030	.166	.165	.25	.07	.19
						1	.038	.040					
						2	.054	.056					
	.112-40 (4-40)	29S	29CLS	29CLA	440	0	.030	.030	.166	.165	.25	.07	.19
						1	.038	.040					
						2	.054	.056					
						3	.087	.091					
	.138-32 (6-32)	29S	29CLS	29CLA	632	0	.030	.030	.1875	.187	.28	.07	.22
						1	.038	.040					
						2	.054	.056					
						3	.087	.091					
	.164-32 (8-32)	29S	29CLS	29CLA	832	0	.030	.030	.213	.212	.31	.09	.27
						1	.038	.040					
						2	.054	.056					
						3	.087	.091					
	.190-24 (10-24)	29S	29CLS	29CLA	024	0	.030	.030	.250	.249	.34	.09	.28
						1	.038	.040					
						2	.054	.056					
						3	.087	.091					
	.190-32 (10-32)	29S	29CLS	29CLA	032	0	.030	.030	.250	.249	.34	.09	.28
						1	.038	.040					
						2	.054	.056					
						3	.087	.091					
	.216-24 (12-24)	29S	29CLS	29CLA	1224	1	.038	.040	.277	.276	.37	.13	.31
						2	.054	.056					
						3	.087	.091					
	.250-20 (1/4-20)	29S	29CLS	29CLA	0420	0	.045	.047	.344	.343	.44	.17	.34
						1	.054	.056					
						2	.087	.091					
						3	.12	.125					
	.250-28 (1/4-28)	29S	29CLS	-	0428	1	.054	.056	.344	.343	.44	.17	.34
						2	.087	.091					
						3	.12	.125					

Thor International Company
10 Ubi Crescent #04-46 Singapore 408564 Tel:+65 67434155 Fax:+65 67421106 Email: sales@thorintl.com

	DIMENSIONS												
	Thread Size	Type: Carbon Steel	Type: Stainless Steel	Type: Aluminium	Thread Code	Shank Code	A (Shank) Max.	Min Sheet Thickness	Hole Size in Sheet + .003 - .000	C Max.	E ±.010	T ± .010	Min Dist Hole C/L To Edge
UNIFIED	.313-18 (5/16-18)	29S	29CLS	-	0518	0	.054	.056	.413	.412	.50	.23	.38
						1	.087	.091					
						2	.120	.125					
	.313-24 (5/16-24)	29S	29CLS	-	0524	0	.054	.056	.413	.412	.50	.23	.38
						1	.087	.091					
						2	.120	.125					
	.375-16 (3/8-16)	29S	29CLS	-	0616	0	.087	.091	.500	.499	.56	.27	.44
						1	.120	.125					
						2	.235	.250					
	.375-24 (3/8-24)	29S	29CLS	-	0624	0	.087	.091	.500	.499	.56	.27	.44
						1	.120	.125					
						2	.235	.250					
	.500-13 (1/2-13)	29S	29CLS	-	0813	1	.120	.125	.656	.655	.81	.36	.63
						2	.235	.250					
	.500-13 (1/2-13)	29S	29CLS	-	0813	1	.120	.125	.656	.655	.81	.36	.63
						2	.235	.250					

All dimensions are in millimeters

	DIMENSIONS												
	Thread Size	Type: Carbon Steel	Type: Stainless Steel	Type: Aluminium	Thread Code	Shank Code	A (Shank) Max.	Min Sheet Thickness	Hole Size in Sheet + .008	C Max.	E ±.025	T ± .025	Min Dist Hole C/L To Edge
METRIC	M2 x 0.4	29S	29CLS	29CLA	M2	0	0.77	0.8 - 1	4.22	4.2	6.3	1.5	4.8
						1	0.97	1					
						2	1.38	1.4					
	M2.5 x 0.45	29S	29CLS	29CLA	M2.5	0	0.77	0.8 - 1	4.22	4.2	6.3	1.5	4.8
						1	0.97	1					
						2	1.38	1.4					
	M3 x 0.5	29S	29CLS	29CLA	M3	0	0.77	0.8 - 1	4.22	4.2	6.3	1.5	4.8
						1	0.97	1					
						2	1.38	1.4					
	M3.5 x 0.6	29S	29CLS	29CLA	M3.5	0	0.77	0.8 - 1	4.75	4.73	7.1	1.5	5.6
						1	0.97	1					
						2	1.38	1.4					
	M4 x 0.7	29S	29CLS	29CLA	M4	0	0.77	0.8 - 1	5.41	5.38	7.9	2	6.9
						1	0.97	1					
						2	1.38	1.4					
	M5 x 0.8	29S	29CLS	29CLA	M5	0	0.77	0.8 - 1	6.35	6.33	8.7	2	7.1
						1	0.97	1					
						2	1.38	1.4					
	M6 x 1.0	29S	29CLS	29CLA	M6	00	0.89	0.92	8.75	8.72	11.05	4.08	8.6
						0	1.15	1.2					
						1	1.38	1.4					
						2	2.21	2.3					
	M8 x 1.25	29S	29CLS	-	M8	1	1.38	1.4	10.5	10.47	12.65	5.47	9.7
						2	2.21	2.3					
	M10 x 1.5	29S	29CLS	-	M10	1	2.21	2.31	14	13.97	17.35	7.48	13.5
						2	3.05	3.18					

* Aluminium self-clinching nuts are only available for sizes 2-56 to 1/4-20 and M2 to M6
* Aluminium self-clinching nuts are only available for shank codes 1 and 2.

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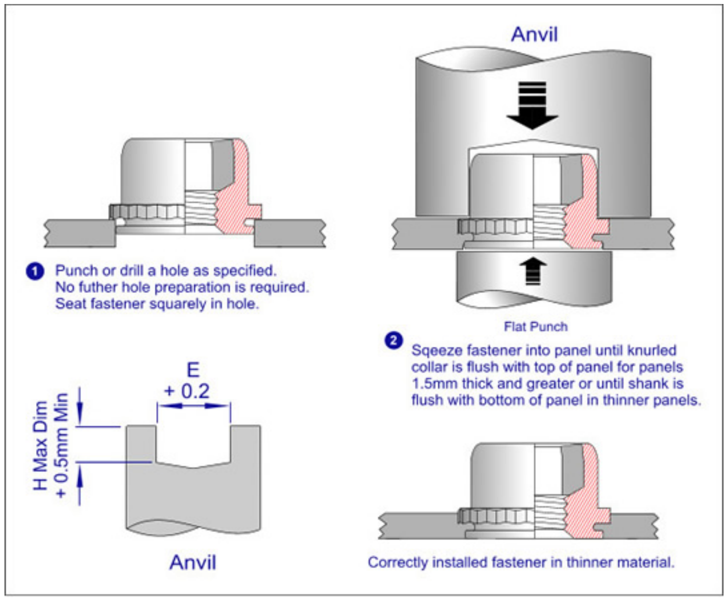
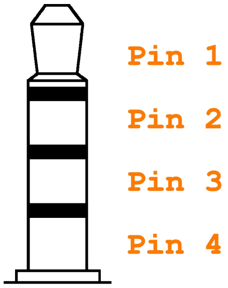


Silicone Moldmaking Techniques & Materials

[Silicon Moldmaking techniques & material guide.pdf]

## 6. Common Connector Pin Out	This is a connector pin out reference.
3.5mm 4pins	**Commonly use for:** - Earphone + Microphone **Earphone + Microphone:** Pin 1- Left Speaker Pin 2- Right Speaker

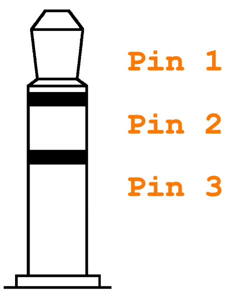


Pin 3- Mic+
Pin 4- Ground

iPhone Mobile Phone Earpiece:
Samsung Galaxy
Samsung Nexus S
Pin 1- Left Speaker
Pin 2- Right Speaker
Pin 3- Ground, Push Switch
Pin 4- Mic+, Push Switch

Nokia Mobile Phone Earpiece:
Pin 1- Left Speaker
Pin 2- Right Speaker
Pin 3- Mic+, Push Switch
Pin 4- Ground, Push Switch

3.5mm 3pins



Commonly use for:
- Earphone
- Speaker

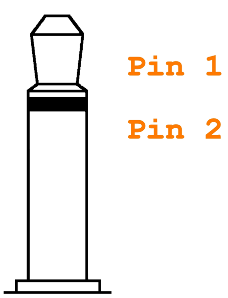
Earphone/Speaker pin out:
Pin 1- Left Speaker
Pin 2- Right Speaker
Pin 3- Ground

Notes: Speaker's load is inductive. Measuring the resistivity from the pins will usually yield very low res short circuit). Measurement by probing the pin in reverse will yield the same result.

Microphone pin out:
Pin 1- Mic+
Pin 2- Mic Power
Pin 3- Ground

Earphone/Microphone pin out:
Pin 1- Spk+
Pin 2- Mic+
Pin 3- Ground

3.5mm 2pins

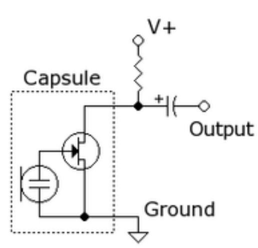


Commonly use for:
- Microphone

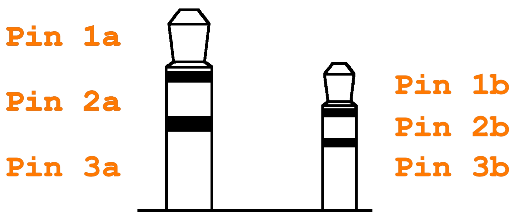
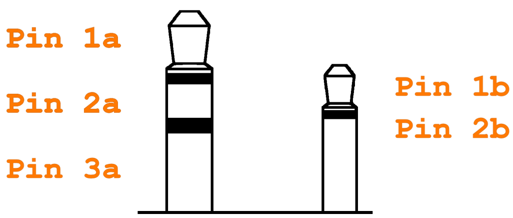
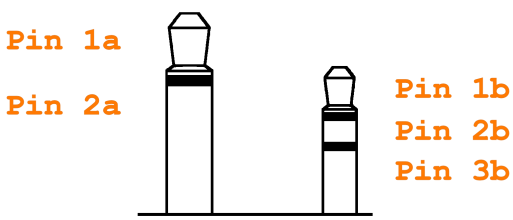
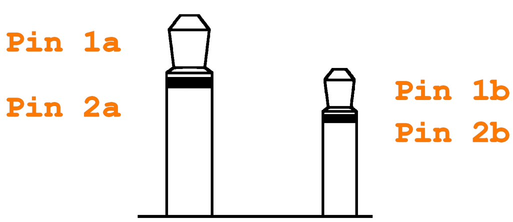
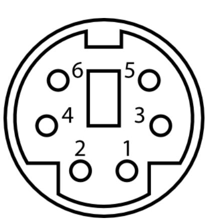
Microphone pin out:
Pin 1- Mic+
Pin 2- Ground

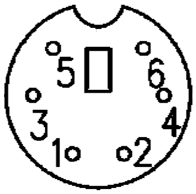
Notes: Commonly available electret microphone contains active components. The positive terminal o can be detected using a ohm meter. Measure Mic+ (+ve Probe), Mic- (-ve Probe) will yield a higher probing the reverse way Mic- (+ve Probe), Mic+ (-ve Probe).

Electret microphone equivalent circuit



Other type of microphone:
- The Carbon Granule Microphone
- The Piezoelectric Microphone
- The Condenser Microphone

	- The Dynamic Microphone - The Ribbon Microphone - The Hot-Wire Microphone reference: http://mysite.du.edu/~jcalvert/tech/microph.htm
3.5mm 3pins, 2.5mm 3pins  	**Known to be use for:** - Walkie talkie
3.5mm 3pins, 2.5mm 2pins  	**Known to be use for:** - Walkie talkie
3.5mm 2pins, 2.5mm 3pins  	**Known to be use for:** - Walkie talkie
3.5mm 2pins, 2.5mm 2pins  	**Known to be use for:** - Walkie talkie
Mini DIN socket 6 pins (female receptacle)  	**Known to be use for:** - Walkie talkie **Walkie Talkie pin out:** Pin 1- Mic- / PTT Switch common Pin 2- Mic+ Pin 3- PTT Switch Pin 4- Speaker+ (left) Pin 5- ---unused--- (right) Pin 6- Speaker-
Mini DIN plug 6 pins (male pins)	**Known to be use for:** - Walkie talkie

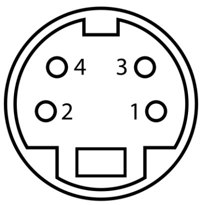


Walkie Talkie pin out:

Pin 1- Mic- / PTT Switch common
Pin 2- Mic+
Pin 3- PTT Switch
Pin 4- Speaker+ (left)
Pin 5- ---unused--- (right)
Pin 6- Speaker-

Pin 1	Mic- / PTT Switch common
Pin 2	Mic+
Pin 3	PTT Switch
Pin 4	Speaker+ (left)
Pin 5	---unused--- or Speaker+ (right)
Pin 6	Speaker-

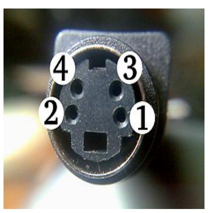
Mini DIN plug 4 pins (male pins)



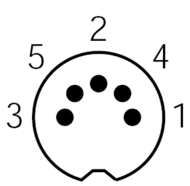
Commonly use for:
- S-Video
- Walkie talkie PTT switch connector

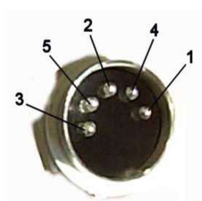
Walkie Talkie pin out:
Pin 1- ---unused---
Pin 2- ---unused---
Pin 3- PTT Switch
Pin 4- PTT Switch

Mini DIN plug 4 pins (female pins)



DIN 5 pins

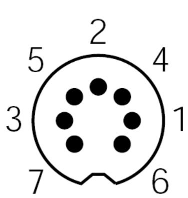




Known to be use for:
- Bike's audio connector

Bike Audio pin out:
Pin 1- ---unused---
Pin 2- ---unused---
Pin 3- PTT Switch
Pin 4- PTT Switch

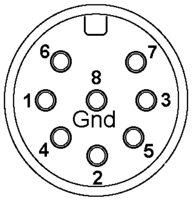
DIN 7 pins



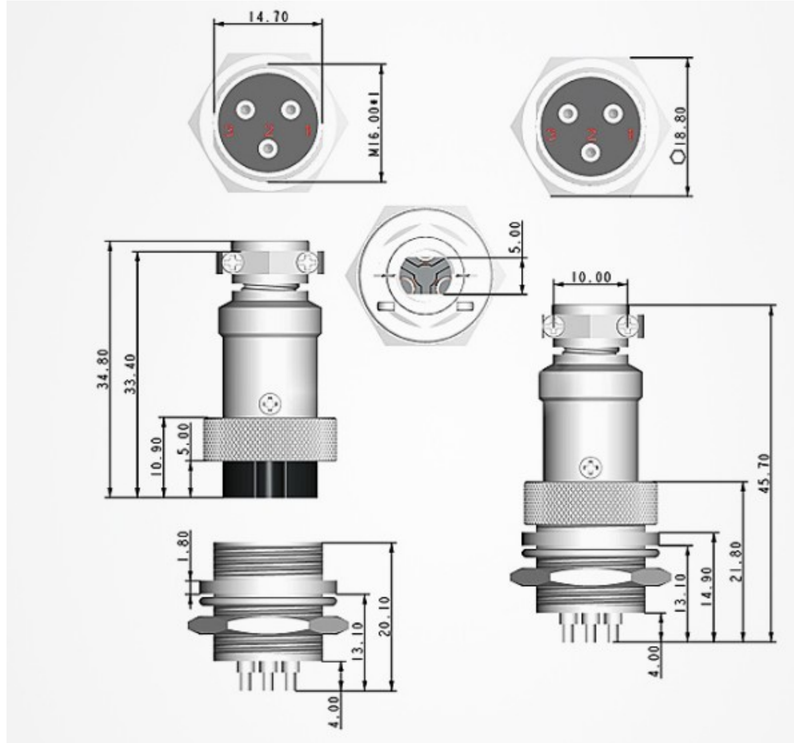
Known to be use for:
- Bike's audio connector

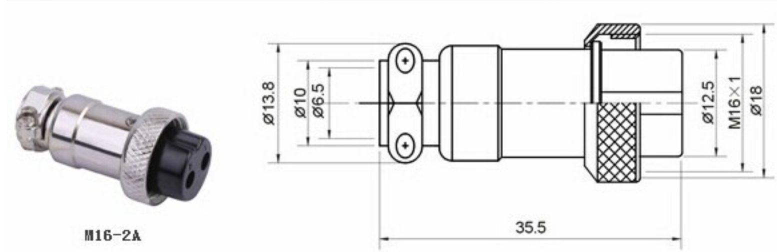
Bike Audio pin out:
Pin 7- PTT Switch (White)
Pin 3- Speaker L
Pin 5- Speaker R
Pin 2- Speaker Gnd
Pin 4- Mic-
Pin 1- Mic+
Pin 6- Mic shield

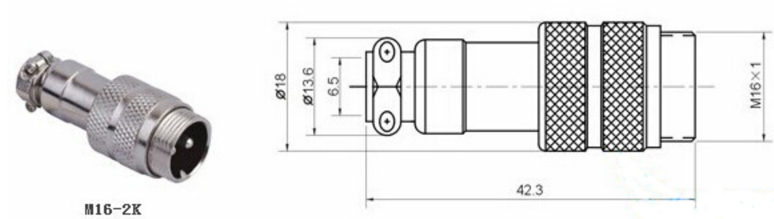
DIN 8 pins

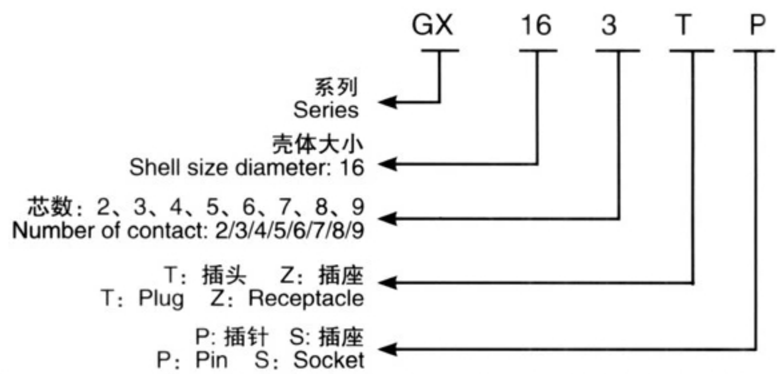


GX16 Aviation plug and socket connectors (16mm)


14.70
M16.00*1
18.80
5.00
10.00
34.80
33.40
10.90
5.00
45.70
1.80
20.10
13.10
4.00
21.80
14.90
13.10
4.00

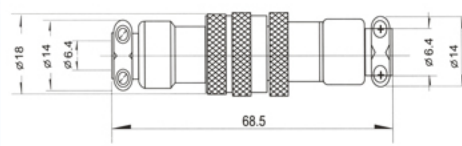

Ø13.8
Ø10
Ø6.5
Ø12.5
M16×1
Ø18
35.5
M16-2A


Ø18
Ø13.6
6.5
M16×1
42.3
M16-2K



接触对排列分布 从针的方向看 Contact Arrangements Comply with the needle direction								
额定电流/电压 Rated current/voltage	7A-125V	7A-125V	5A-125V	5A-125V	4A-125V	4A-125V	4A-125V	4A-12
工作电压(AC. V)分钟 Operatin limit voltage(AC.V.rms)	200	200	200	200	200	200	200	20
耐电压(AC. V)1分钟 Withstanding voltage (AC.V.rms)1minute	1500	1500	1500	1500	1500	1500	1500	150
绝缘阻抗(MΩ)DV500V Insulation resistance(MΩMIX.) At DC 500V	1500	1500	1500	1500	1500	2000	2000	200
接触阻抗(MΩ)DC1A Contact resistance(MΩMIX.) AT DC 1A	3	3	3	3	3	3	3	3
接触对孔径 φ(mm) Soldre inter diameter	2.45	2.45	2.45	2	1.15	1.15	1.15	11

FD-M16 16mm Connectors



FD-M16 型对接针脚参数

针脚数 No. Of Pin	16-2	16-3	16-4	16-5	16-6	16-7	16-8	16-9
触点排列 Contact Arrangements								
接触对直径数量	Φ2.5x2	Φ2.5x3	Φ2.5x4	Φ2x5	Φ1.2x6	Φ1.2x7	Φ1.2x8	Φ1.2x9
额定电流/电压	15A/250V	15A/250V	15A/250V	10A/250V	5A/250V	5A/250V	5A/250V	5A/250V
耐电压(AC.V)1分钟	1500	1500	1500	1500	1500	1500	1500	1500
绝缘阻抗(MΩ)DV500v	2000	2000	2000	2000	2000	2000	2000	2000

Nanaboshi Connectors
(panel mount)

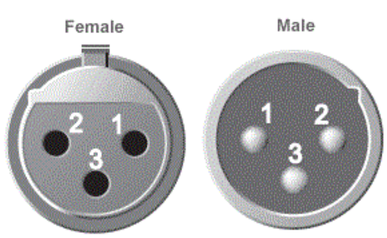
NJC series (general metallic connectors/socket)
NR series (twist lock connector, one-touch lock mechanism)
NJW series (waterproof panel mount connectors/socket)

connector/Nanaboshi%20Connectors%20NJC%20NR%20Series.pdf
connector/nanaboshi%20njc%20panel%20mount%20connector.pdf
connector/nanaboshi%20connectors.pdf

Amphenol Connectors
(panel mount)

connector/amphenol%20connectors.pdf

XLR Plug 3 pins



Commonly use for:
- Studio Microphone

Studio Microphone pin out:
Pin 1- Shield
Pin 2- Positive Balance Signal
Pin 3- Negative Balance Signal

<table>
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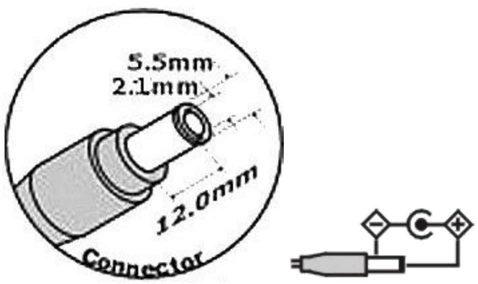
DC barrel jack/socket

DC barrel jack (OD=5.5mm, ID=2.1mm, length=11 to 12mm)



DC barrel socket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SMA RF connector (socket for WiFi Antenna)


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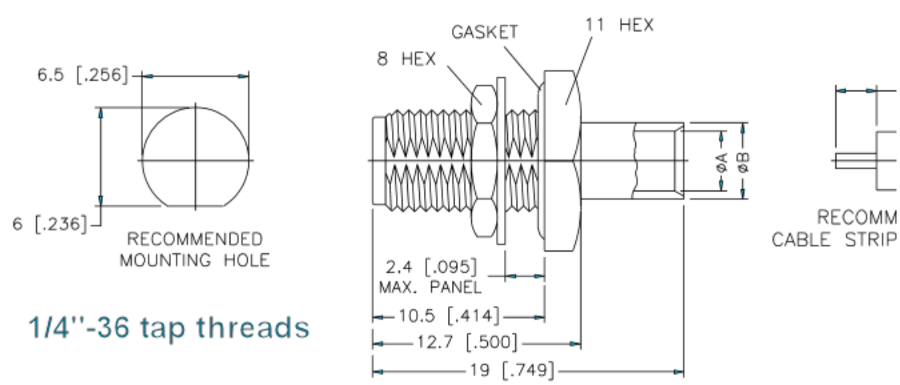
Toggle switch dimension, drill hole dimension and thread size 1/4-40 UNS-2A



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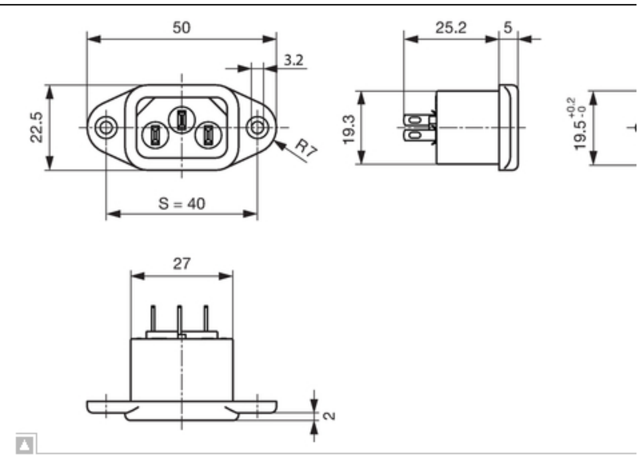
7. Name of Connectors/Plugs	
UK 3 pins Plug 	
EU 2 pins Plug 	
IEC 3 pins Socket  Male Plug -> IEC C14 (picture shown above) Female socket -> IEC C13 Male Plug (with groove) -> IEC C16 Female socket (with groove) -> IEC C15 Check out here for more, https://en.wikipedia.org/wiki/IEC_60320	
	General Product Family Crimp Terminals


Molex SPOX 5267 series connector header THT 2.5mm 4 way


Molex 5263 housing crimp receptacle 2.5mm 4 way

2.54mm pitch

Series	5263
Product Name	SPOX™
UPC	800753534919
Physical	
Gender	Female
Material - Metal	Phosphor Bronze
Material - Plating	Mating Tin
Material - Plating	Termination Tin
Net Weight	43.200/mg
Plating min - Mating	0.889µm
Plating min - Termination	0.914µm
Termination Interface: Style	Crimp or Compres
Wire Insulation Diameter	1.90mm max.
Wire Size AWG	22, 24, 26, 28
Wire Size mm²	NA
Old Part Number	5263PBTL


molex KK 6410 series

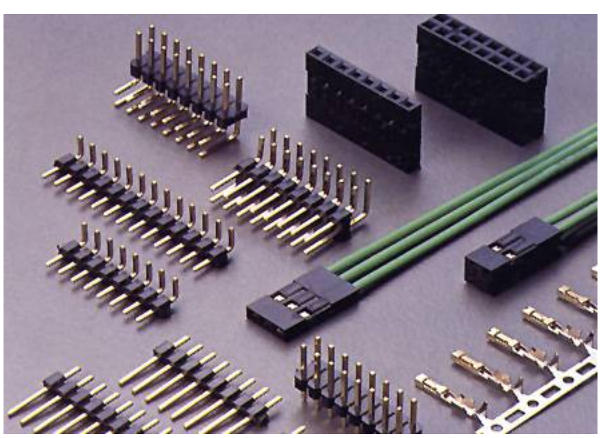

molex KK 6471 crimp receptacle

2.54mm pitch

General	
Product Family	Crimp Terminals
Series	4809
Product Name	KK®
UPC	800753746022
Physical	
Gender	Female
Material - Metal	Brass
Material - Plating	Gold
Material - Plating	Gold
Net Weight	0.066/g
Plating min - Mating	0.381µm
Plating min - Termination	0.381µm
Termination Interface: Style	Crimp or Compres
Wire Insulation Diameter	1.57mm max.
Wire Size AWG	22, 24, 26, 28, 30
Wire Size mm²	NA
Old Part Number	4809555L

TJC8 connector (header and housing/receptacle pins)

Another name for housing is receptacle.

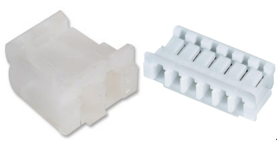
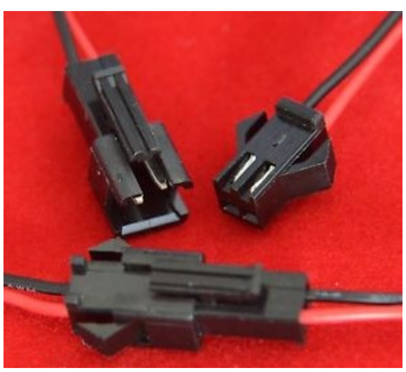
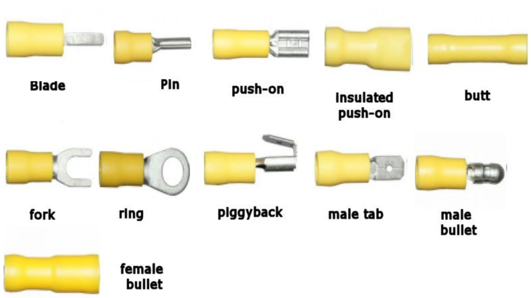


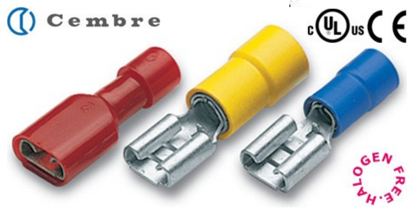
Pin Header PCB Crimp Style Cable Connector

TJC8 series(2.54mm pitch)Wire to Board Crimp style cable P.C.B conn header

1. Pole: 1-40
2. Housing pins for wire size AWG28# - 22#
3. Header pins for PC board thickness: 1.6mm, 2.54mm pitch
4. Temperature range: -25C~85C
5: Voltage rating: 250V. AC/DC
6. Current rating: 3A
7. Contact resistance: 0.02
8. Insulation resistance: 800M
9. Withstand Voltage: 1000V. AC/1Min
10. Material:
Housing: PA66
Wafer: PBT
Terminal: Phos. Bronze Tin plated

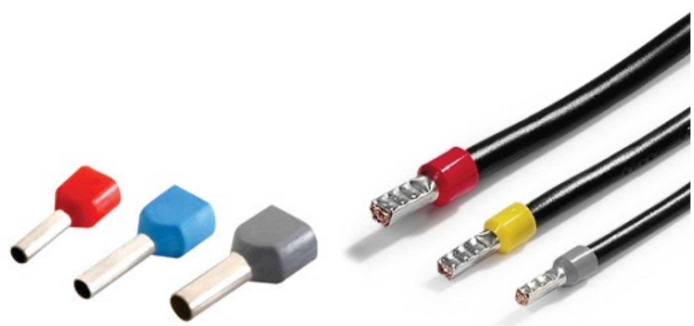
Crimping tool, die sets size = ???

	
JST ZH connectors  B3B-ZR(LF)(SN)  S3B-ZR(LF)(SN)  ZHR-3  SZH-002T-P0.5 SZH-002T-P0.5 (0.08-0.13mm2, AWG28# - 26#, OD 0.8-1.1mm) SZH-003T-P0.5 (0.032-0.08mm2, AWG32# - 28#, OD 0.5-0.9mm)	
JST EL-2P (2 Way) Multipole Connectors With Wire 	
	Connectors > Crimp Terminals / Solder Terminals & Splices > Quick Dis Crimp terminal, Blade, Pin, Push-on Insulated push-on, Butt, Fork, Ring, Piggyback, Male tab (6.35mm or 1/4 inch tab connector), Male bullet, Female bullet



Red Insulation 0.5-1.5mm2 / 22-16 AWG
Blue Insulation 1.5-2.5mm2 / 16-14 AWG
Yellow Insulation 4.0-6.0mm2 / 12-10 AWG

Good terminal is made of copper (tinned), not aluminium.

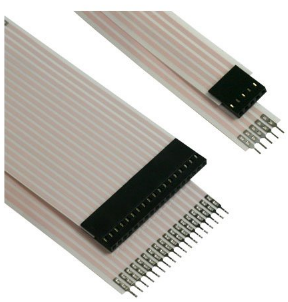


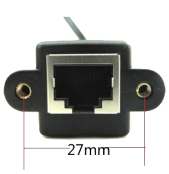
Cord End Ferrules					
French Type			German Type		
Part No.	Colour	Conductor Size (mm²)	Barrel Length (mm)	Colour	Part No.
CEF025F	Violet	0.25	6	Light Blue	CEF025G
CEF034F	Pink	0.34	8	Turquoise	CEF034G
CEF508F	White	0.5	8	Orange	CEF508G
CEF7508F	Blue	0.75	8	White	CEF7508G
CEF108F	Red	1.0	8	Yellow	CEF108G
CEF1508F	Black	1.5	8	Red	CEF1508G
CEF2508F	Grey	2.5	8	Blue	CEF2508G
CEF409F	Orange	4	9	Grey	CEF409G
CEF612F	Green	6	12	Black	CEF612G
CEF1012F	Brown	10	12	Ivory	CEF1012G
CEF1612F	Ivory	16	12	Green	CEF1612G
CEF25016F	Black	25	16	Brown	CEF25016G
CEF35016F	Red	35	16	Beige	CEF35016G

Wire size for various ferrule size (color determine the size)

Ferrule

8. Name of Cable/Wire

Ribbon Cable & IDE connectors 	IDC connector pin rating is 1A.
Flat Flexible Cable (FFC) 	
Flex Jumper 	

9. Others	
RJ45 (Panel Mount), Ethernet network socket, 8P8C plug to socket   	
USB Socket (Panel Mount)	

panel%20mount%20USB%20s

email: mail@siongboon.com
website: http://www.siongboon.com

Keyword: mm inch mil thou, tap drill size, reference guide, PCB trace resistivity computation calculator, Foot print reference, Cable wire gauge resistance, cable wire selection, fastener

Power supply for LCD clock
LCD clock power supply

Between the various wrecks I have been spending time with a larger LCD display. When I found them to be almost nothing, I installed them in the workshop. The clocks were originally fed by a single button link, but I wanted to **never** have to worry about powering them anymore . Consideration was given to the power supply from the battery or battery back-up. For mains power, however, the clock would either be galvanically connected to the grid (in the case of a "condenser" source), or I would have to agree with another permanently connected transformer in the household, which also has an idle consumption of about 1 W. For power I finally used the " " Tension. The connection in FIG. 1 completely eliminates the two aforementioned drawbacks.

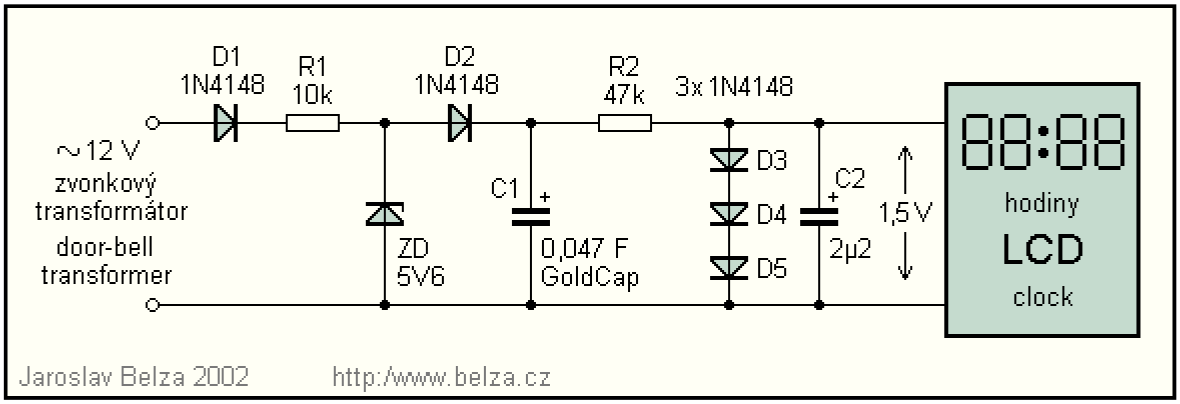
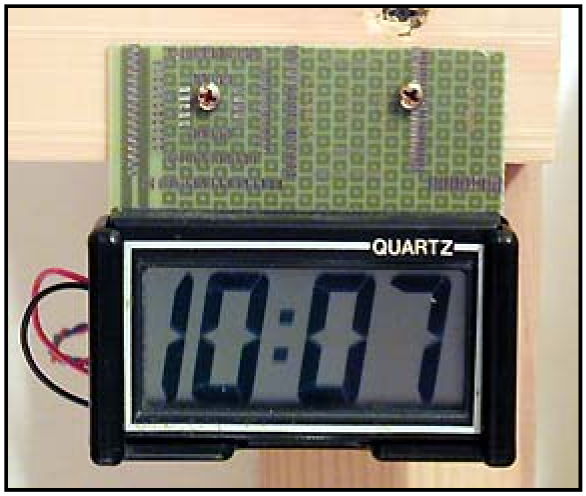


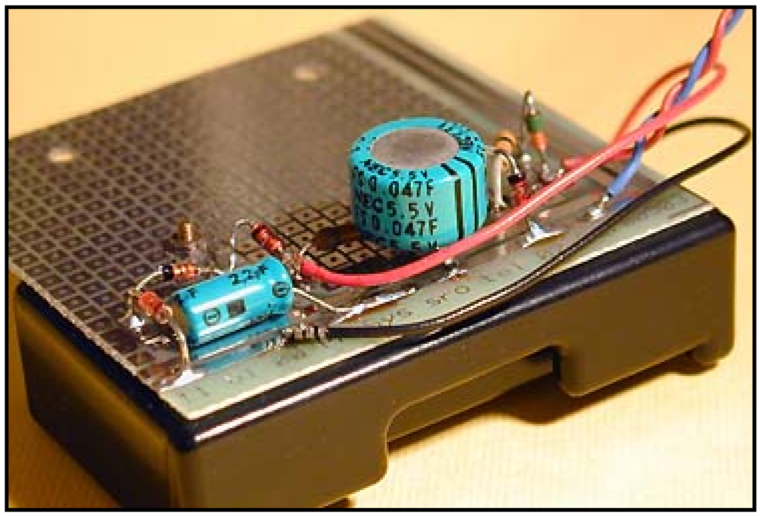
Fig. 1. Clock Source
Fig. 1. Clock power supply

Description involvement

The alternating voltage from the transformer is one-way diode D1 and limited by Zener diode to about 5.5 V. This voltage is charging a special miniature capacitor C1 (GoldCap). These capacitors are manufactured with special technology, allowing you to reach an incredible capacity of up to 1 Farad. I got the capacitor from an older radio where it was used to power the preset station memory. Since the radio had "forgotten" after a few days, the capacitor was replaced by a NiCd battery that was even more strenuous. In newer car radios, as far as I know, this method is no longer used and the memory is backed by permanent battery power. GoldCap capacitors have a maximum voltage of 5.5 V and only currents can be discharged and charged up to several mA, otherwise they will be destroyed. In my circuit the capacitor backs up the clock when the mains voltage drops. The voltage from the capacitor is withdrawn through R2 and is stabilized to about 1.5 volts by diodes D3 to D5. The capacitor is capable of feeding the clock for several hours when the power supply is interrupted. The biggest load is the stabilizer, the actual clock collection is negligible. After the modification, it would probably be possible to replace the somewhat exotic C1 accumulator RAM.

Source I realized from what was at hand on a piece of universal board. She has been fully satisfied for several years.





Jaroslav Belza

26. 3. 2002

Capacitor Meter with Large Capacity
Large C meter

The meter can measure the capacity of conventional electrolytic capacitors with an accuracy better than 10%. Any power source with a voltage of 5 to 15 V can be used for the power supply. The only condition is that the voltage does not change much during the measurement.

Description involvement

After switching on, the measured capacitor Cx is charged via resistor Rn. The voltage on the measured capacitor is compared with the voltage on the dividers from resistors R2 and R3 by a comparator formed by the operational amplifier OZ1. With a higher supply voltage, the capacitor charges faster, but it has to be charged at a higher voltage to flip the comparator. Therefore, the time interval over which the comparator is overturned is independent of the supply voltage.

During the charging of the capacitor, the comparator output is practically zero voltage and a constant current source consisting of transistors T1 and T2 is triggered. The capacitor C1 is charged over it. The voltage on this capacitor is proportional to the time it was charging, and thus the capacity of the Cx capacitor. The voltage at C1 indicates a handheld measuring device connected via an OZ2 tracker.

The splitter R2, R3 is connected only after the diode D1, which moves the DC voltage level. This adjustment causes a small change in the switching time of the comparator depending on the supply voltage. In this way, the dependence of the current source on the supply voltage is compensated, mainly due to the change of current passing through the resistor R5. The displacement of the supply voltage is also necessary for proper operation of the OZ2 tracker.

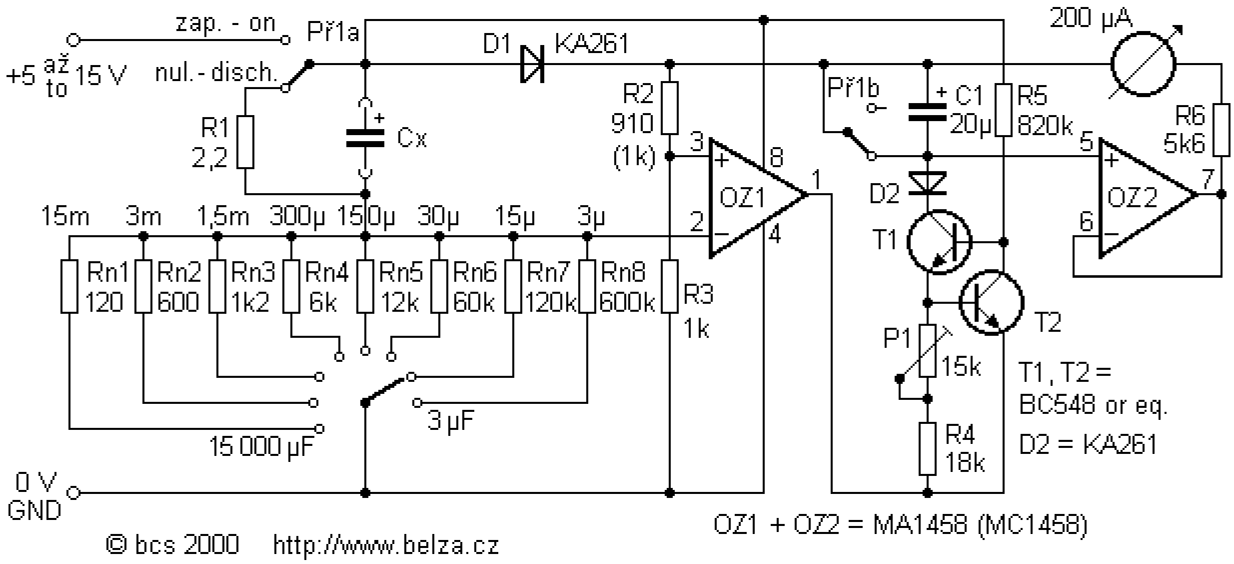


Fig. 1. Electrolytic capacitor meter
Figure 1. Large C meter

Measuring procedure

We connect the measured capacitor, select the appropriate range and turn on the device. The gauge of the gauge will slowly increase until after about 1 second it has stabilized at a value corresponding to the measured capacity. By switching off the device, the measured capacitor is discharged and the instrument is ready for further measurement by discharging the capacitor C1. It is advisable to repeat the measurement several times, especially for capacitors that have not been in operation for a long time. The first measurement will show more capacity because some of the energy is consumed to form the condenser.

Device design

Most of the components are on the printed circuit board of **Figures 2 and 3**. The design of the device is evident from the photograph. The meter does not have its own source, I use a stabilized source or battery for occasional measurements. Resistor R1 limits the discharge current of the measured capacitor. I used a coil of wire resistance, it does not matter much. The switching current Pr1 should also be dimensioned on the discharge current. Considering that the measured capacitor is charged at a voltage close to the supply voltage, this current may be several amperes. I used a meter with a 200 micrometre (0.1 V) full-wave current, for others the resistance of the resistor will have to be adjusted so that the full deflection is at a voltage of 1 to 1.5 V. The Rn resistors determine the range of the instrument. It is not necessary to keep their resistance exactly, the relative ratio of the resistances is important. The Rn resistors are composed of two resistors connected in series to make the desired set-up easier. If you use both resistors,

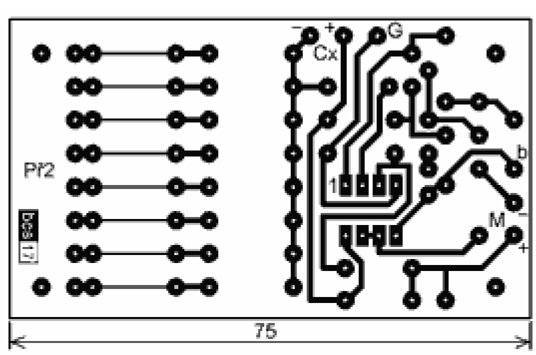


Fig. 2. Circuit board of electrolytic capacitor meters. Click to get a picture at 600 dpi
Figure 2. C meter PCB layout. Click to get 600 dpi resolution image

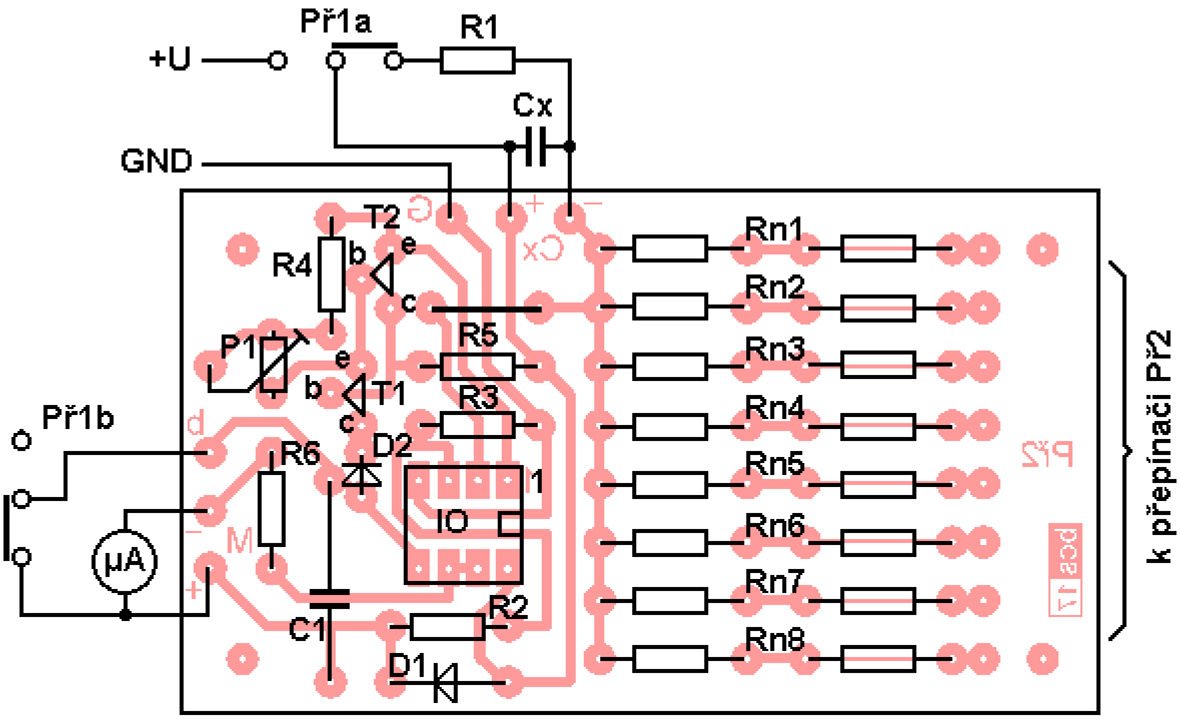


Fig. 3. Layout of components on the board
Figure 3. Locations of components on the board

Device setup

If RN resistors are selected in advance, you only need to set the instrument in one range. With Cx, we connect a capacitor of known capacity and choose the appropriate range. Rotate the P1 to set the desired gauge of the gauge. Every time you turn the trimmer, you must always re-measure it! In some cases, it may be necessary to change the resistance of resistor R4.

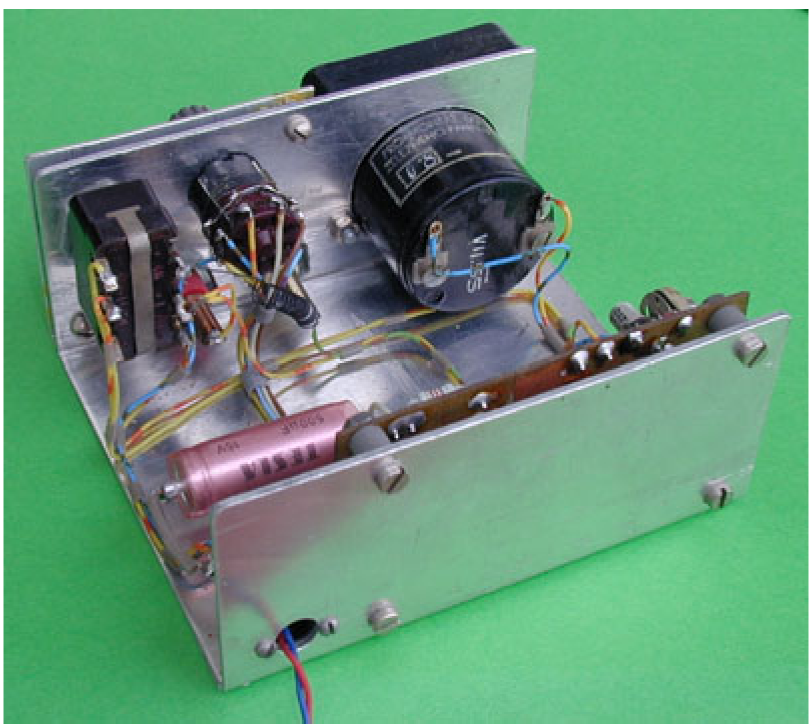


Fig. 4. Rear view
Figure 4. Rear inside view

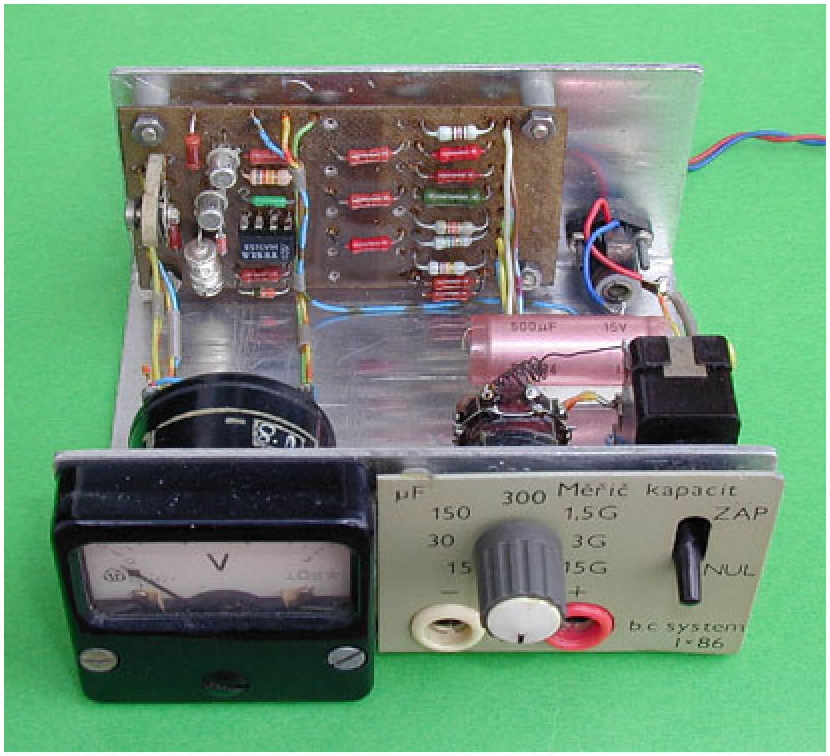


Fig. 5. Front view
Figure 5. Front inside view

List of parts

R1	2.2 Ohm, wire (or piece of resistance wire)
R2	910 Ohm (or 1 kohm)
R3	1 kOhm
R4	18 kOhm
R5	820 kOhm
R6	5.6 kOhm
P1	15 kOhm
Rn1	120 Ohm, for a range of 15,000 µF
Rn2	600 Ohm, for a range of 3,000 µF
Rn3	1.2 kOhm, for a range of 1 500 µF
Rn4	6 kOhm, for a range of 300 µF
Rn5	12 kOhm, for a 150 µF range
Rn6	60 kOhm, for 30 µF range
Rn7	120 kOhm, for a range of 15 µF
Rn8	600 kOhm, for 3 µF range
NO. 1	20 µF (22 µF) / 16 volts, preferably tantalum
D1, D2	KA261 (1N4148 etc)
T1, T2	BC ... (KC508, BC548, BC238, 2N3904, 2SC945 ...)
IO	MA1458
Pre1	Double switch, Double pole - double throw
Ex2	8-pole switch, 8-pole single throw

M	Hand gauge 200 µA
Circuit board	bcs17
	sockets, power connector, box

Jaroslav Belza

The electrolytic capacitor meter was printed in Amateur Radio No. 2/1990 at p. 49. At its design I was inspired by the involvement in [1], where it is the original source. [2]

[1] Kalás, L .: Progressive Capacity Meter . Amateur Radio No. 4/1977 p. 146.
[2] Popular Electronic, October 1976

10. 9. 2000

CMOS-TTL
CMOS-TTL Logic Probe Logic Probe

Approximately in 1984, the first CMOS circuits appeared in TESLA stores. The use of CMOS circuits in various connections is very advantageous, especially for their negligible power input. The basic tool for working with logic circuits is a logic probe. The logical probe design, which is suitable for working with CMOS circuits, is described here. This probe is one of the first to appear on the AR site.

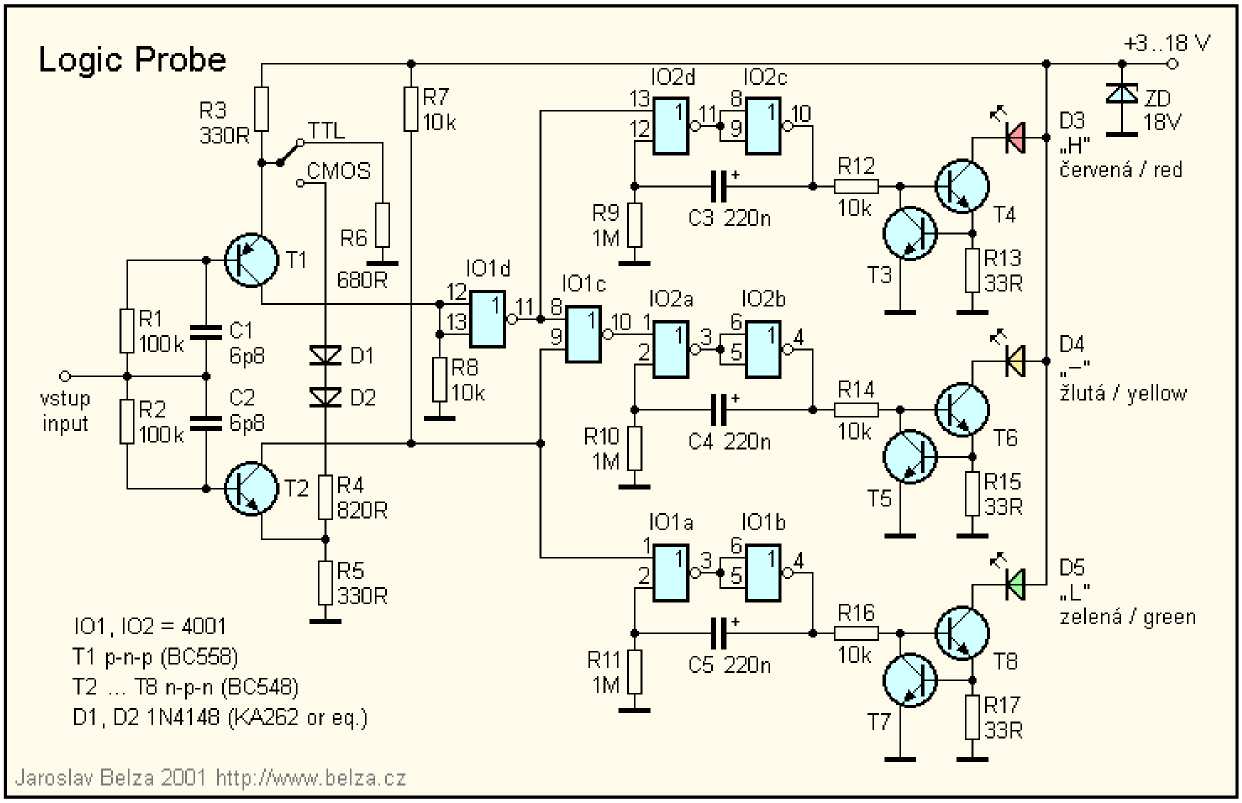


Fig. 1. Wiring the CMOS-TTL Logic Sensor
Figure 1. CMOS-TTL Logic Probe

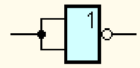
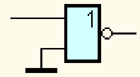
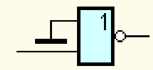
Activity description

The logic probe (the wiring diagram in **Figure 1**) indicates three states: logical "0" (level L), logical "1" (level H) and indeterminate state. Short impulses are extended by monostable flip-flops. Dynamic properties are sufficient to work with conventional CMOS circuits, the probe captures impulses from 200 ns above. It should be noted that TTL and HCMOS circuits are able to produce pulses shorter and they will no longer catch the probe. The power supply voltage of the probe can be 3 to 18 volts and the probe is normally supplied from the object being measured. Decision levels are approximately 30% Ucc (CMOS) and 0.8V (TTL) for the log. 0 and 70% Ucc (CMOS) and 2.5V (TTL) log. 1. TTL decision levels apply to the 5 V supply voltage. An indeterminate state indicates the probe also when the probe tip is not connected anywhere.

Probe circuits

The input circuit is resolved to monitor logical TTL and CMOS levels. A simple switch is used for switching, the voltages for each decision level are fixed by resistors. The D1 and D2 diodes compensate for voltage drops at base-emitter transitions in transistors T1 and T2. When using the TR12 and TR15 transistors, they must be selected with a breakdown voltage greater than 15 V. It is a problem to get the correct logic level at the gate H1 when the switch is switched to the TTL position. At a supply voltage of 5 V, the voltage at gate input is within 0 to 3 V; it changes depending on whether T1 is opened or closed. Therefore, two completely random selected IO MHB4001 pieces were targeted in different wiring. The results are in **tab. 1**. If in the first case (both inputs in parallel) the tilting level is greater than 2.9 V, this does not mean the IO is defective, but it is not suitable for use in the probe. Three identical monostable multivibrators are connected to the logic to distinguish individual levels, which extends short pulses to about 0.2 s. Indefinite level indications are also extended to indicate short pulses that do not reach logical levels. If this extension is not needed, simply disconnect the C4 capacitor.

Tab. 1. Retraction level of NOR gateways (MHB4001) Table 1. Treshold level two different NOR gate

connection	.vzorek 1.	.vzorek 2.
	2.21 V	2.34 V
	2.59 V	2.73 V
	2.71 V	2.87 V

The MCU outputs control current sources for the LEDs. It is advantageous to supply LEDs from current sources, since they are almost the same in the entire supply voltage range. The current through the diode can be adjusted by selecting a different resistance of resistor R13 (or R15 or R17). This can compensate for the luminosity of individual diodes. I used different colors for the indication: it will improve the clarity of the read data. The Zener diode D6 and the fuse in the power supply provide protection for the probe when the supply voltage is incorrectly connected.

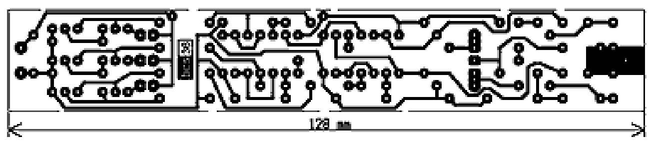


Fig. 2. Printed circuit board of the receiver. Click to get a picture at 600 dpi
Figure 2. Receiver PCB layout. Click to get 600 dpi resolution image

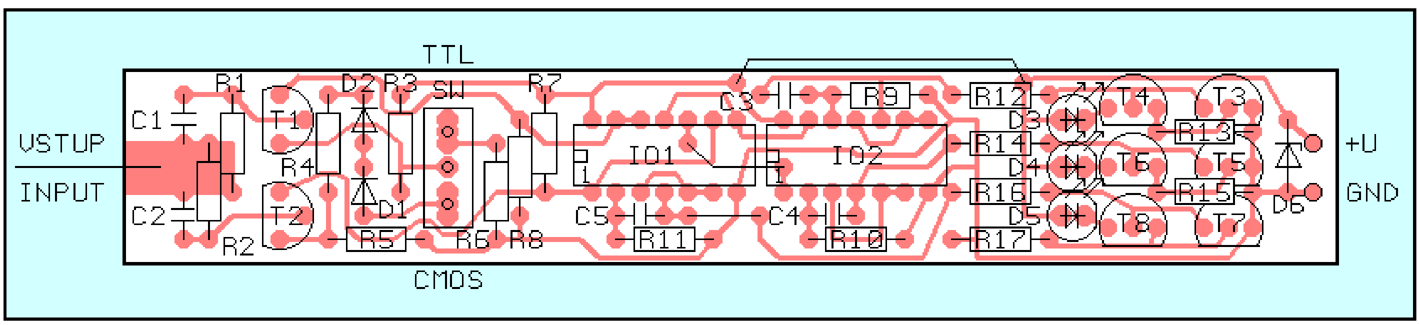


Fig. 3. Layout of components on the board
Figure 3. Locations of components on the board

Construction

The components of the logic probe are connected to a printed circuit board (**Figure 2**), the arrangement of the components is **shown** in **Fig. 3**. I redraw and modified the original AR board. If you use the original V60 plate, you need to scratch the connection between IO1 terminals 6 and 7 - there is an error on the original board. I made the box for the probe from polystyrene. The warning tables served as its source; the content of the tables in this case does not matter :-)). The indication diodes are stuck in the probe cover and are connected by thin wires. They can be soldered directly to the board here, but in this case they are already far from the tip, which makes work with the probe uncomfortable. At the front end of the probe, a screw clamp is fastened to which either a steel spike or wire is attached. It is possible to connect the probe to the measured location without having to keep it in hand. Resistor resistors are designed for common LEDs. If you use a small current LED (2 mA), it is necessary to increase the resistance of resistors R13, R15 and R17 to 270 to 330 Ohms. This modification significantly changes the current consumption. When installing the board, be sure to have three wire jumpers. The overall arrangement of the probe is evident from the photograph on**Fig. 4** .

Revival

We connect the finished probe over the milliammeter to the power supply and slowly increase the supply voltage - preferably from 0V. The current to be discharged should not be greater than 3 to 10 mA plus the current of the diode switched on. We also test the function of the probe across the entire supply voltage range. Then it is ready for use.

List of parts

R1, R2	100 kOhm, all miniature resistors

R3, R5	330 Ohm
R4	820 Ohm
R6	680 Ohm
R7, R8, R12, R14, R16	10 kOhm
R9, R10, R11	1 MOhm
R13, R15, R17	33 ohm (330 Ohm for LED @ 2 mA)
C1, C2	6.8 pF, ceramic
C3, C4, C5	220 nF, tantalum TE125 or foil or ceramic
IO1, IO2	CMOS 4001 (MHB4001)
T1	TR15 or other switching pnp or BC558
T2	TR12 or other switching npn or BC548
T3 to T8	any npn (BC548)
D1, D2	KA261, 1N4148 and the like.
D3, D4, D5	ICE
D6	Zener diode 18 V, eg KZ260 / 18
	circuit board bcs36 or V60

Fig. 4. Logic probe with removable cover - older versions of printed circuit board (V60)
Figure 4. Logic Probe without cover (older version PCB)

Connecting a similar logic probe

Jaroslav Belza

Amateur Radio Series A 9/1987 p. 330

24. 10. 2001

Home page - hlavní stránka

How to determine the coaxial cable impedance?

How to determine the coaxial cable impedance?

The impedance of an unknown coaxial cable can be reliably estimated by its capacity. The specific capacity of the coaxial cable, ie the capacity per 1 meter length is determined by the formula

$$C_m = \frac{2\pi\varepsilon}{\ln(D/d)} = \frac{2\pi\varepsilon_0\varepsilon_r}{\ln(D/d)}$$
,

where *ε* is the cable dielectric permit, *D the* diameter of the outer sheath (shield) and *d* the inner conductor diameter. However, the same data also determines the characteristic impedance of the cable:

$$Z = \frac{Z_0}{2\pi\sqrt{\varepsilon_r}} \cdot \ln\left(\frac{D}{d}\right) \approx \frac{60}{\sqrt{\varepsilon_r}} \cdot \ln\left(\frac{D}{d}\right)$$
.

It is not necessary to recalculate the formulas, it is sufficient to realize that the permitivity differs according to the dielectric used, but for the conventional cables these constants are similar. The relative permitivity of conventional dielectrics used in cables is similar and the capacity of the cable with the same impedance is proportional to its square root. Polyethylene Permitivity (RG-174 / U) is εr = 1.52, foamed polyethylene (by cable type) εr = 1.2 to 1.37.
Therefore, use a low-capacity capacitance meter (to avoid cable and reflection), measure capacity and share the length of the cable in meters.
The capacity of conventional 50Ω cables is around 100 pF / m, cables with a typical impedance of 75 Ω around 65 pF / m and 93 Ω (95 Ω) cables around 50 pF / m.
You can identify a cable from old stock, out of stock or stock exchange. Interesting data on cables and dielectrics can also be found from these links

http://www.rfcafe.com/references/electrical/coax-chart.htm
http://www.pulsedpower.net/Info/common_dielectrics.htm

Characteristic impedance **Characteristic impedance**	**Capacity of** **cable capacitance cable**
50 Ω	approx. 100 pF / m

75 Ω	approx. 65 pF / m
93 Ω	approx. 50 pF / m

Jaroslav Belza

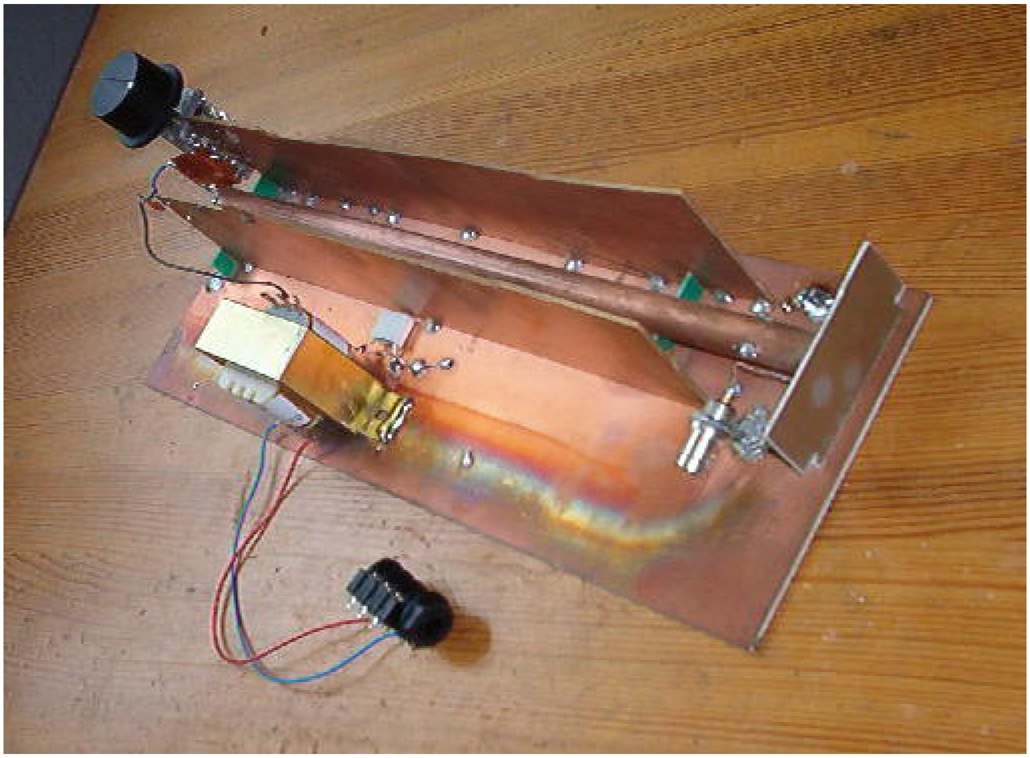
The article was published in the magazine "Practical Electronics" 4/2016 p. 28
This article was published in "Practical Electronics" magazine 4/2016, page 28

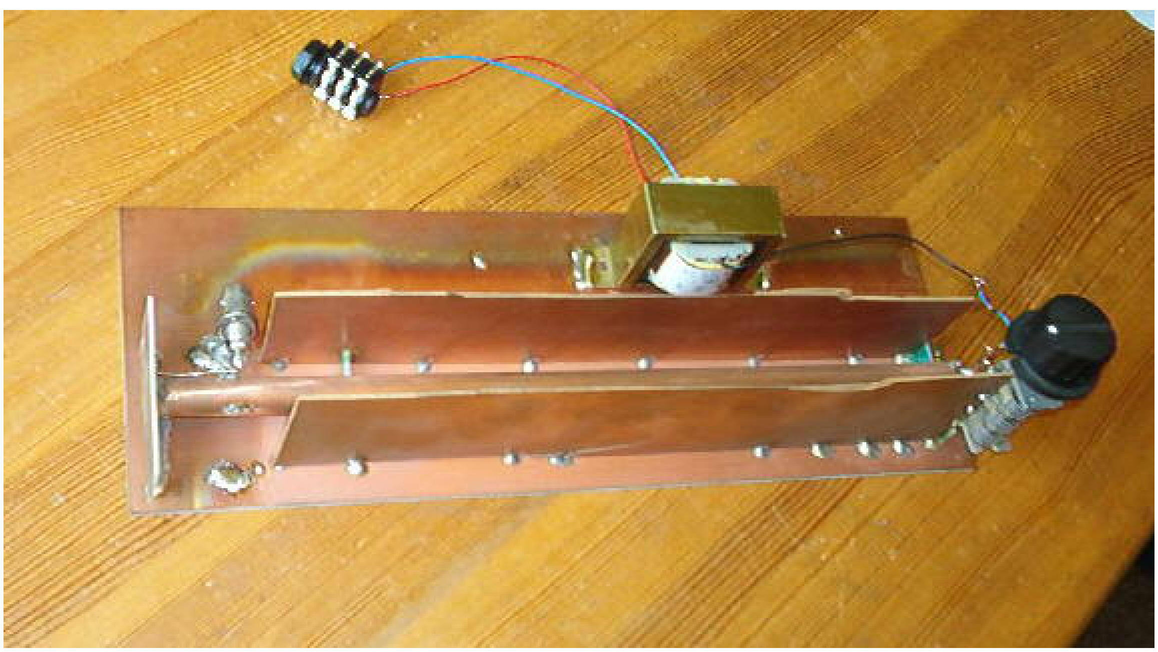
31. 10. 2017

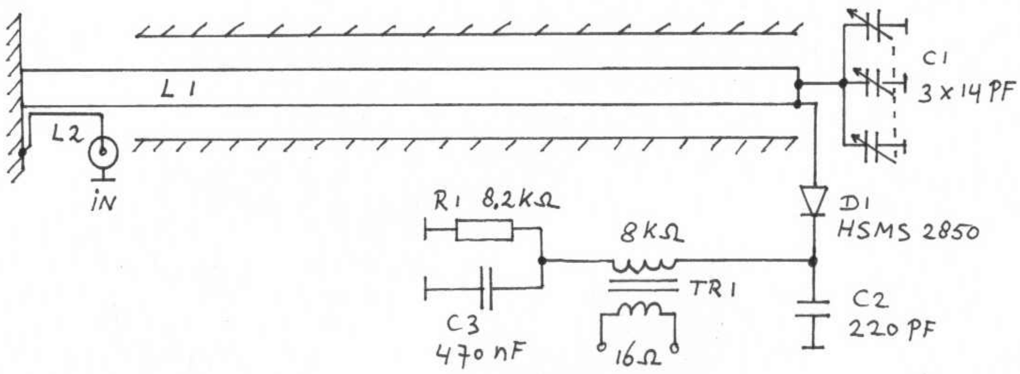
Set 6
FM crystal receiver.

Back to the index

This receiver can receive stations in the FM band (87-108 MHz).







Schematic description:

The receiver has a tuned circuit made with variable capacitor C1 and coil L1.
Coil L1 is a 285 mm long copper tube, the outside diameter is 12 mm.
Via coil L2 the input signal is coupled to L1.
L2 and L1 are placed parallel over a distance of 25 mm.
The wire diameter of L2 is 0.5 mm, and the spacing with L1 is about 1 mm.

On both sides of L1 are placed copper plated PCB boards.
The spacing between the boards and L1 is 10mm
The spacing between L1 and the bottom plate is also 10mm.

The bottom plate is also made of copper plated PCB board.

The "earth" side of L1 is via a small piece of PCB connected with the bottom plate. There must be very good contact between bottom plate and L1, so solder it very carefully.

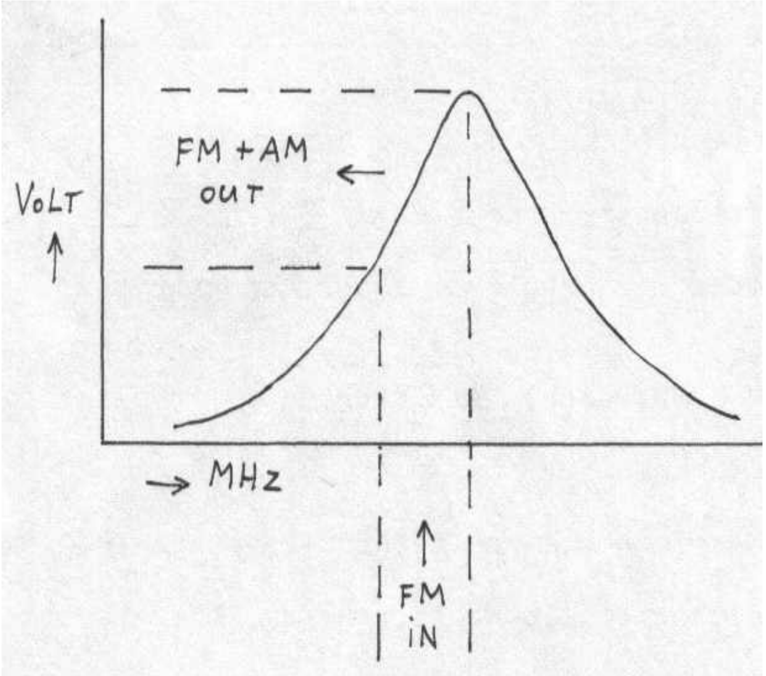
The copper tube (L1) must be clean and free of oxide, otherwise selectivity en sensitivity will decrease.

The transformer is model TR10.16 made by Visaton.

This receiver is a slope detector.

The receiver must be tuned a little bit beside the station’s frequency.

The input signal is placed on the slope of the filtercurve, a FM modulated signal will now also obtain some AM modulation.
This AM modulation can be detected by a diode.



For reception I use a [3 elements directional antenna.](http://crystal-radio.eu/)

It has a gain of about 5 dB.

With the antenna placed only 1.5 meter high, I could receive the following stations:

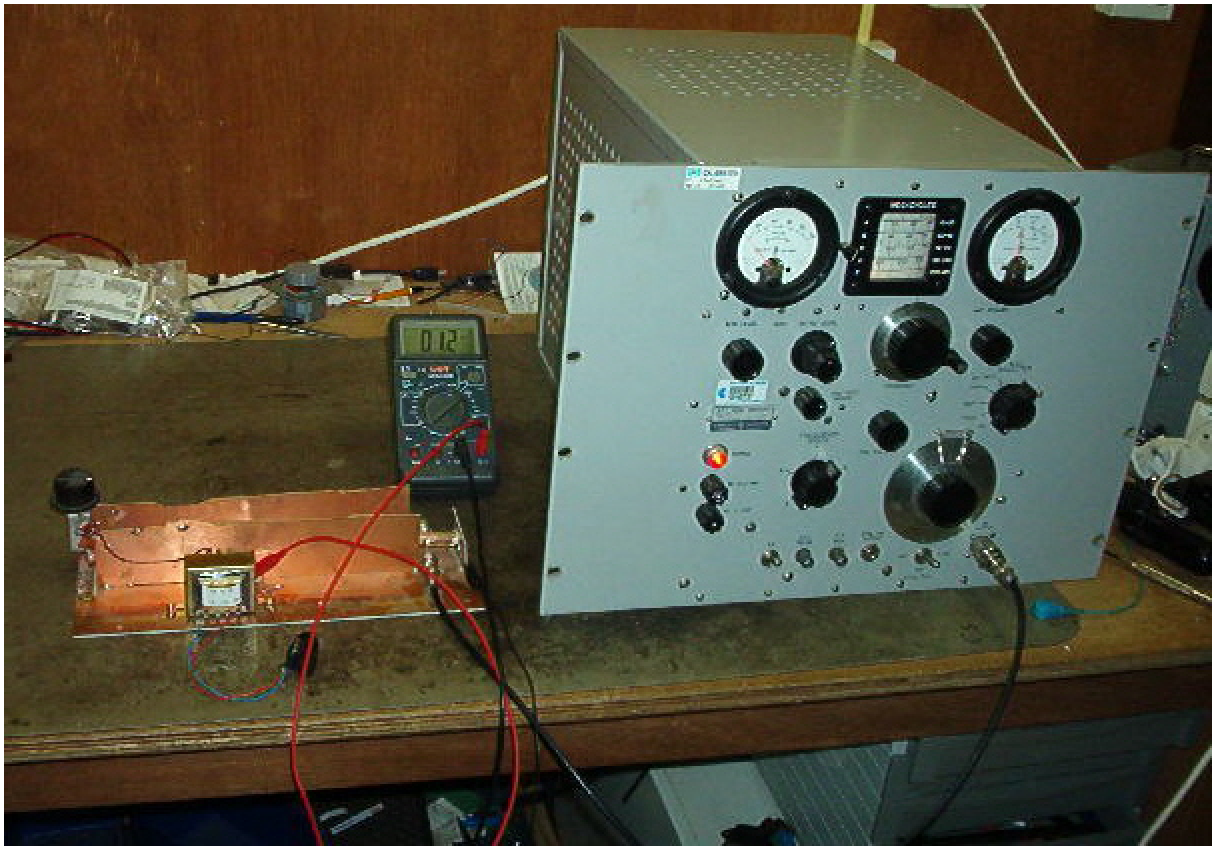
Station	MHz	Location	kW	km
Arrow	90.7	Lopik	100	17
Radio 2	92.6	Lopik	100	17
Radio 4	94.3	Lopik	100	17
Radio 3	96.8	Lopik	100	17
Radio 1	98.9	Lopik	100	17
BNR Nieuwsradio	100.1	Lopik	100	17
Noordzee FM	100.7	Lopik	100	17

The output signal is fairly weak, so use a sensitive speaker, for instance a driver unit.

Sensitivity test

On the picture below you see the test setup for measuring the sensitivity of the receiver, on the right you see a VHF signal generator.

At an input power of -40 dBm and a frequency of 100 MHz the DC voltage over R1 is 1.6 mV.



Diode test

In this receiver I tested the following diodes:
- One OA95 germanium diode (Rd = ± 45 kΩ)
- One HSMS2850 schottky diode (Rd = ± 9 kΩ)
- One BAT62-03W schottky diode (Rd = ± 225 kΩ)
- Two BAT62-03W diodes parallel (Rd = ± 112 kΩ)
- Four BAT62-03W diodes parallel (Rd = ± 56 kΩ)

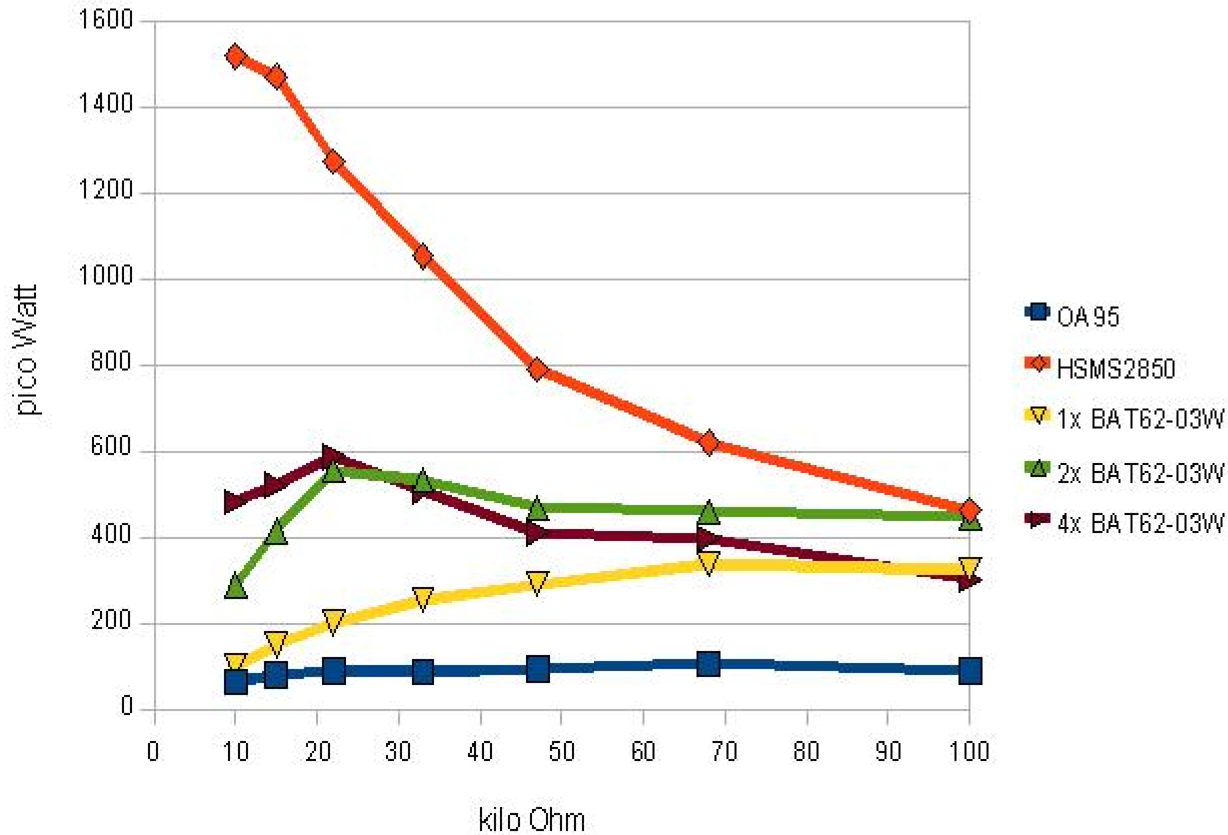
At several load resistor values between 10 and 100 kΩ , the rectified output voltage is measured (in milliVolt).
And from this the output power in the load resistor is calculated (in pico Watt).
The measurements are done at 100 MHZ and -35 dBm input power in the receiver.

The following table gives the results:

Load (kΩ)	OA95 (mV)	OA95 (pW)	HSMS2850 (mV)	HSMS2850 (pW)	1x BAT62-03W (mV)	1x BAT62-03W (pW)	2x BAT62-03W (mV)	2x BAT62-03W (pW)	4x BAT62-03W (mV)	4x BAT62-03W (pW)
10	0.8	64	3.9	1521	1.0	100	1.7	289	2.2	484

15	1.1	81	4.7	1473	1.5	150	2.5	417	2.8	523
22	1.4	89	5.3	1277	2.1	200	3.5	557	3.6	589
33	1.7	88	5.9	1055	2.9	255	4.2	535	4.1	509
47	2.1	94	6.1	792	3.7	291	4.7	470	4.4	412
68	2.7	107	6.5	621	4.8	339	5.6	461	5.2	398
100	3.0	90	6.8	462	5.7	325	6.7	449	5.5	303

This graph shows the power in the load resistor as function of the load resistor value.



We see, the HSMS2850 gives the most output power.
The OA95 has the worst performance, probably this germanium diode is not fast enough for 100 MHz signals.

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Set 1

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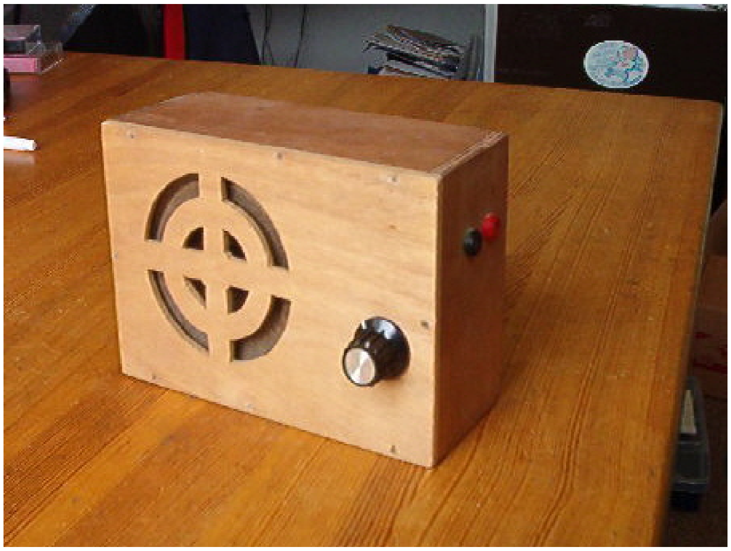
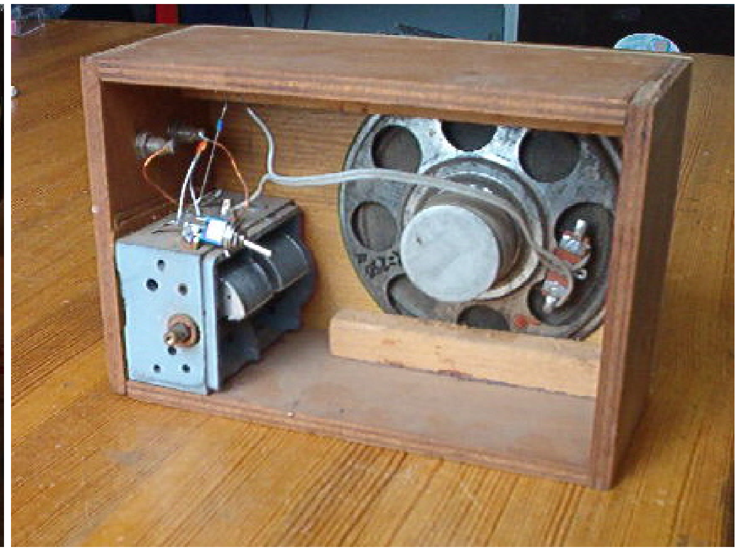

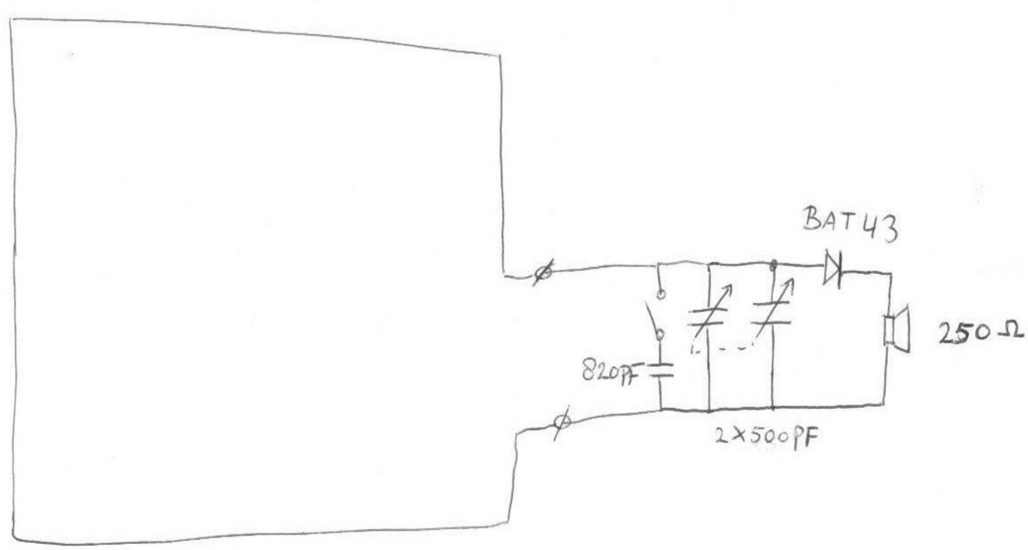

This is the first crystal receiver I built.

The receiver must be connected to a large frame aerial, which is a loop of copperwire.
I am using a loop which measures 4x6 meter which I have suspended in my shed.
One strong local station can be heard (120 kw at 17 km distance).
The sound can be heard all over the shed.

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Set 3

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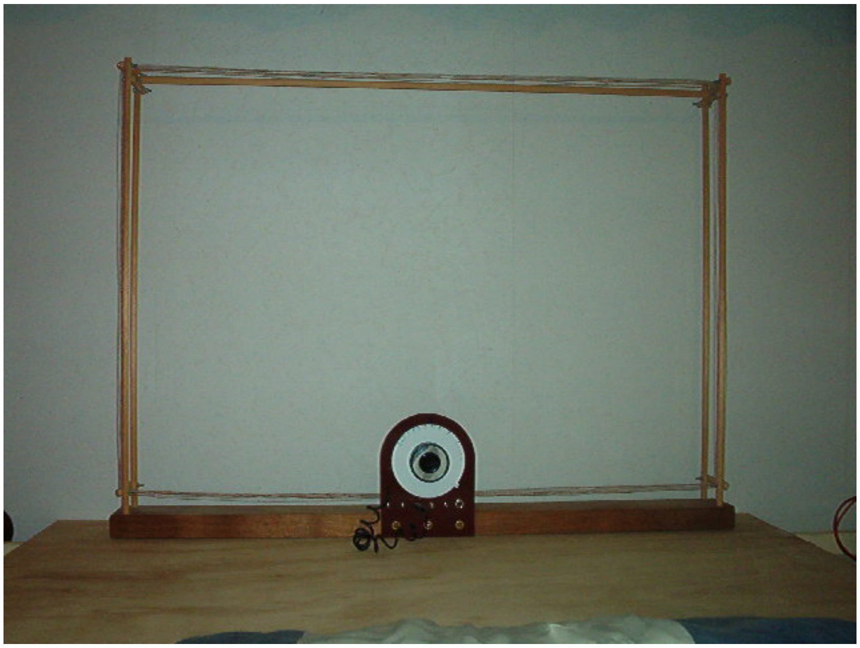


This receiver uses a loop antenna, which is a large coil.
The coil picks up energy from the transmitter, so there is no need for any external antenna or ground connection.
The coil is 88x60 cm and has 8 turns.

The receiver has a calibrated frequency dial. In receivers with a external antenna this is not possible, because de length of the antenna influences the tuning frequency.

On the coil there are several taps for connecting the diode. I got the best results with the tap in the middle of the coil.

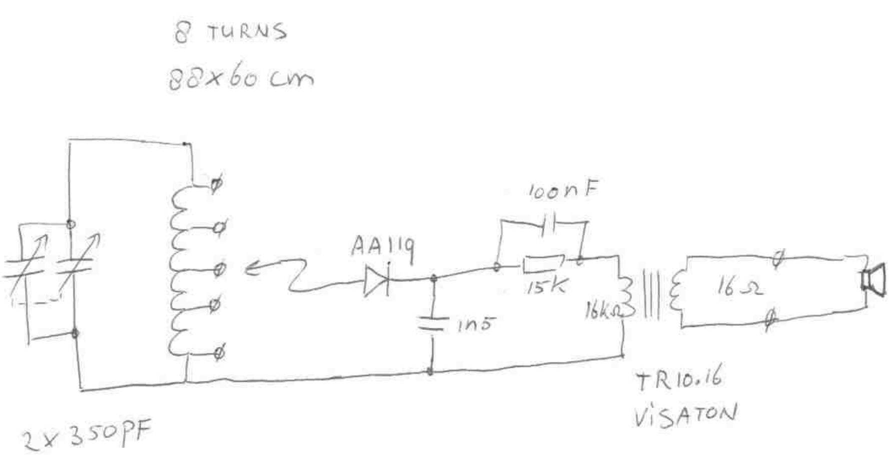
An audio transformer transforms the impedance from 16 kΩ primary to 16 Ω secondary.
As a speaker we can use a modern headphone, with both 32 Ω speakers connected in parallel.

I received 33 different stations with this radio.
The loop antenna is directional, so sometimes we must turn the receiver for better reception.

The coil is made of litzwire 40x0.07. This wire has 40 individually insulated 0.07 mm strands.
With this wire we can make coils of high quality.

The unloaded Q factor of the LC circuit is as follows:

Frequency (kHz)	Q factor
600	128
900	146
1200	144
1500	124



Circuit diagram of receiver "set 3"

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Set 10 Receiver with loopantenna

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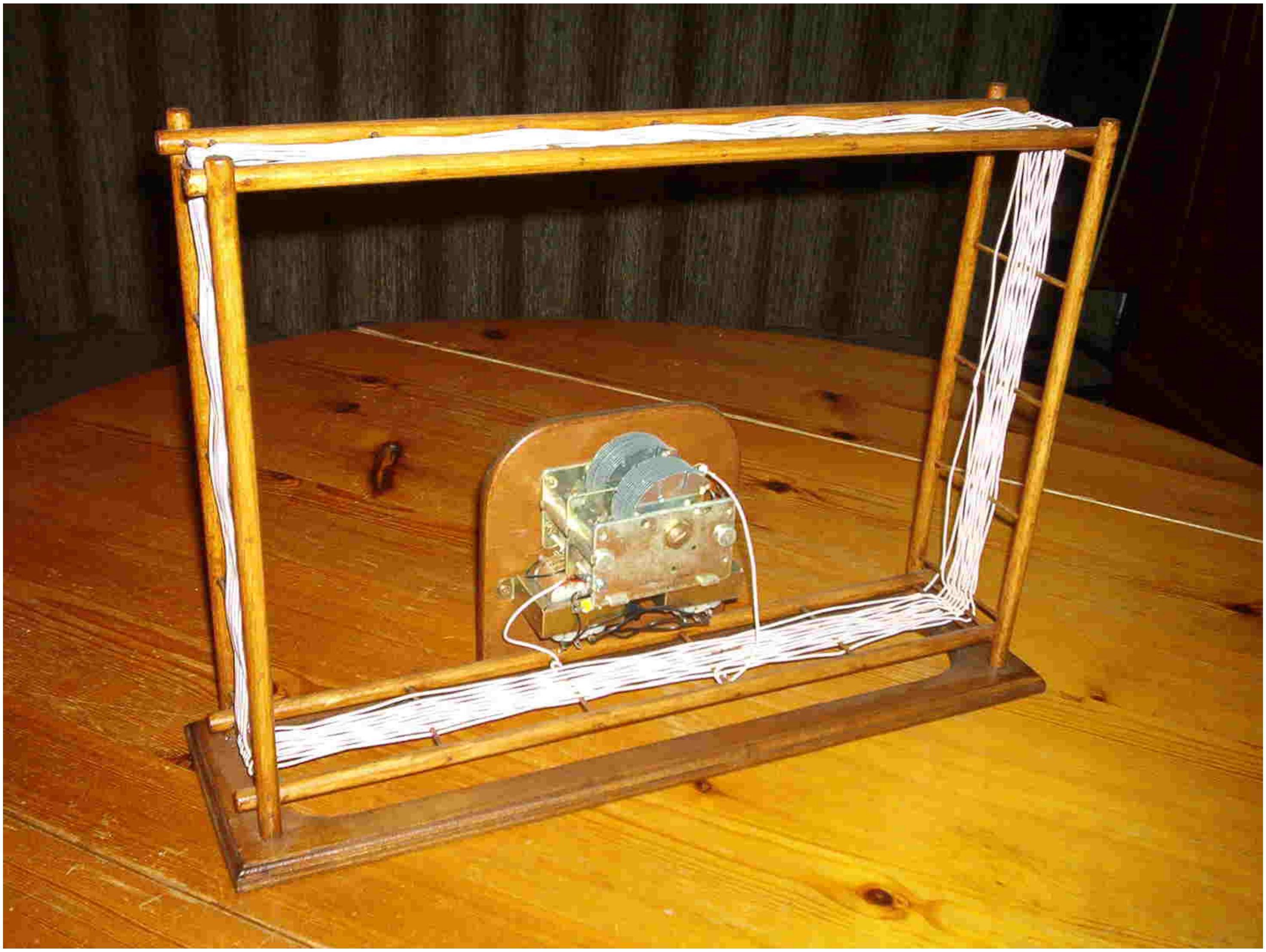
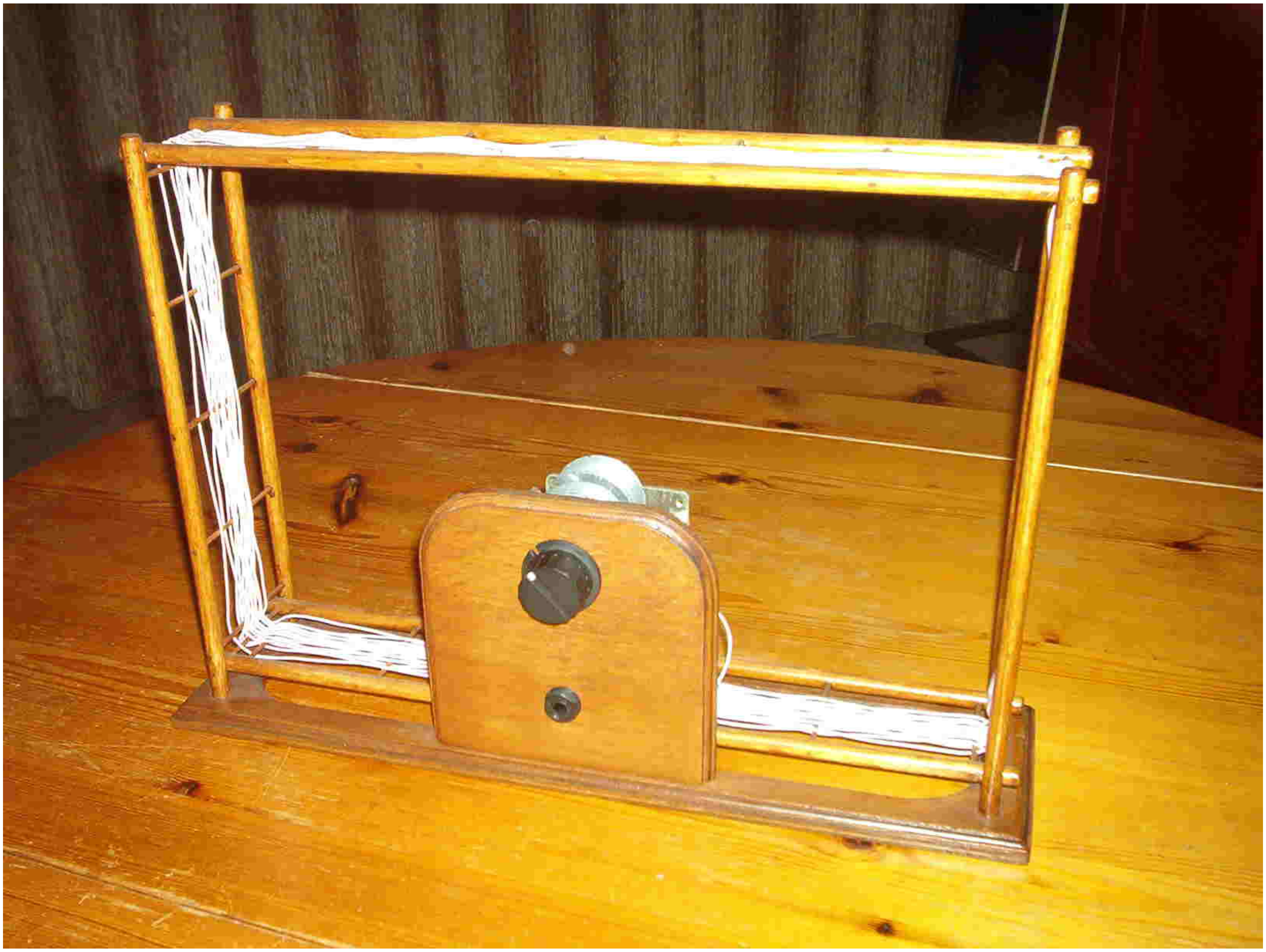
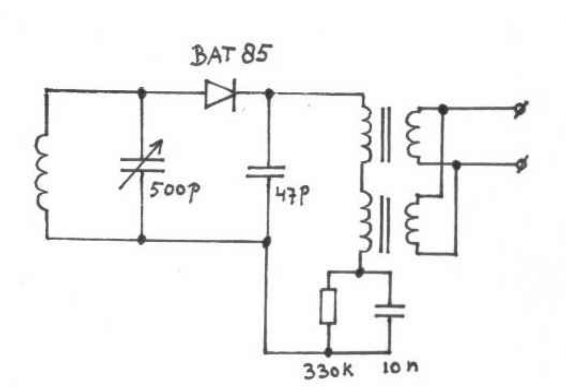
This receiver has a 26x38 cm loop antenna, made of 660x0.04 mm litzwire.
The loop antenna has 16 windings, and is wound around a frame made of wooden sticks.







Circuit diagram:

Set 10

The transformers (type: 952.431) are with the 16 Ω output windings parallel connected, this gives an impedance of 8 Ω.
The connected headphone however gives a load which is twice as high (16 Ω).
This will make the input impedance of the transformers (normally 80 kΩ) almost double.
The total input impedance of the two transformers will now be about 300 kΩ.

As loudspeaker, a modern headphone is used (Sennheiser model: HD202).

With this receiver I took part in the Elmar memorial crystal radio dx contest 2006, and received 4 stations:
See the Contestlog Elmer 2006.xls

During the Dutch BTTF crystalreceiver contest (december 2005) I received 6 stations with this receiver.
See the Contestlog BTTF 2005.xls

However, the number of received stations was quite low.

I measured the Q factor of the complete receiver, which was quite low (see measurement 1).
To find out the reason, first the diode was disconnected, this increased the Q quite a lot (measurement 2).
Then the two transformers were removed (measurement 3), because they were at close distance to the coil, there was influence on Q factor.

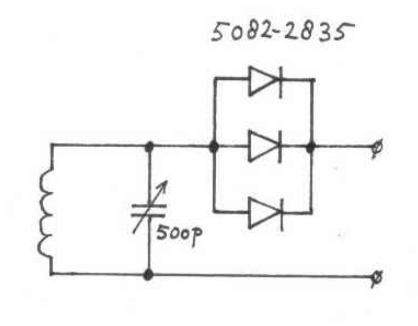
The next measurements are done with 1.4 Volt peak-peak across the LC circuit

Measurement		Q 600 kHz	Q 900 kHz	Q 1200 kHz	Q 1500 kHz
1	Set 10 Complete receiver Loaded with headphone	136	107	72	64
2	Diode disconnected	300	264	206	182
3	Transformers removed	500	388	285	214
4	3x 5082-2835 diode and 1M5 load	333	265	203	160

Then I connected 3 schottky diodes (5082-2835) in parallel to the receiver (measurement 4).
In measurement 4, a load resistor of 1.5 MΩ is used, because this is about the impedance of my transformator unit1.

Set 10 version 2

Then I replaced the 1.5 MΩ resistor (measurement 4) by the transformer unit 1, and connected a driver unit to it.
Both sensitivity and selectivity of the receiver was now much better then first.
With this version of the receiver, I took part in 2006 in a contest, and received 24 stations.
See the Contestlog sprint 2006.xls



Circuit diagram of: set 10 version 2
At the output, transformer unit 1 is connected.

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Crystal receiver set 11

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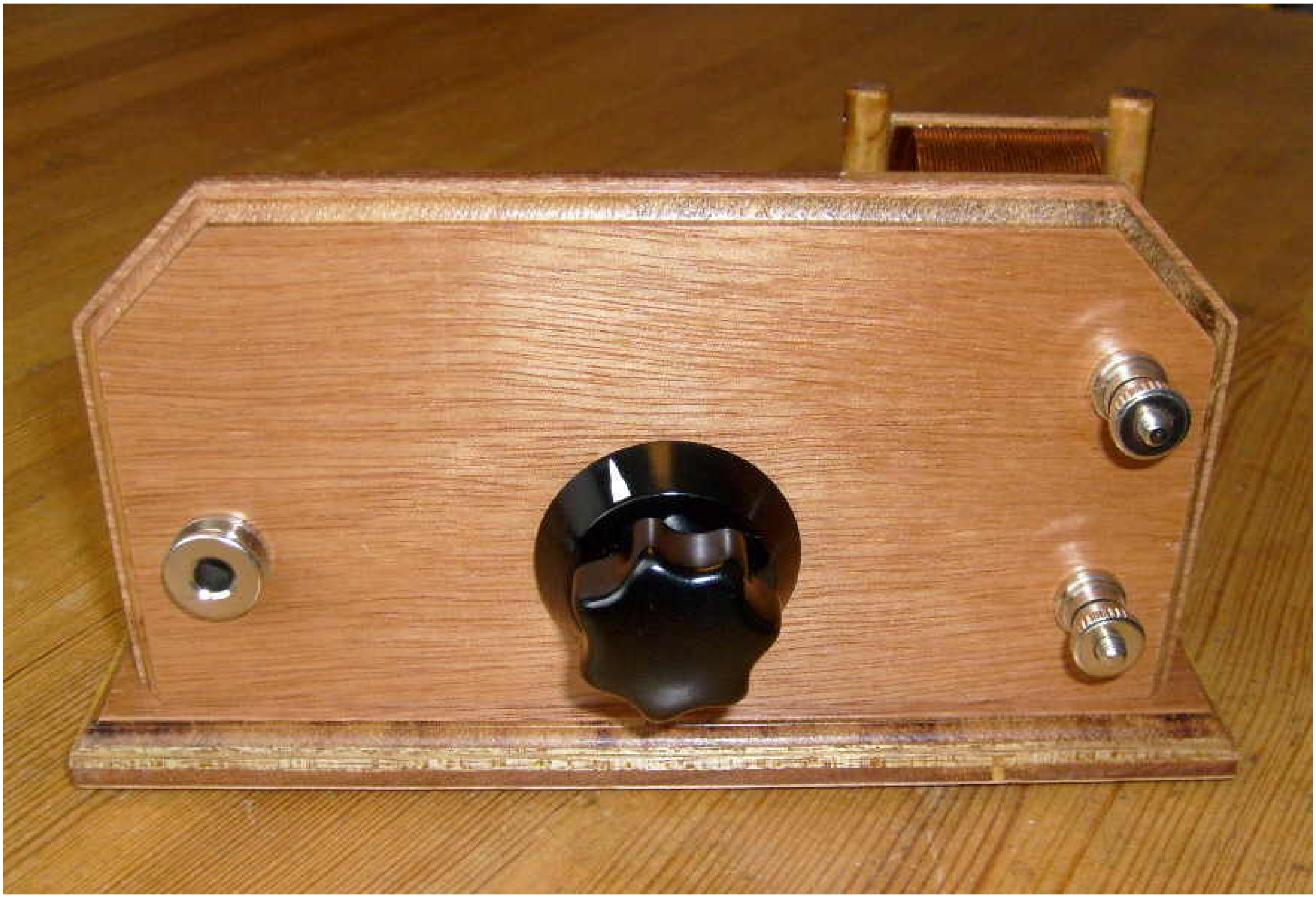
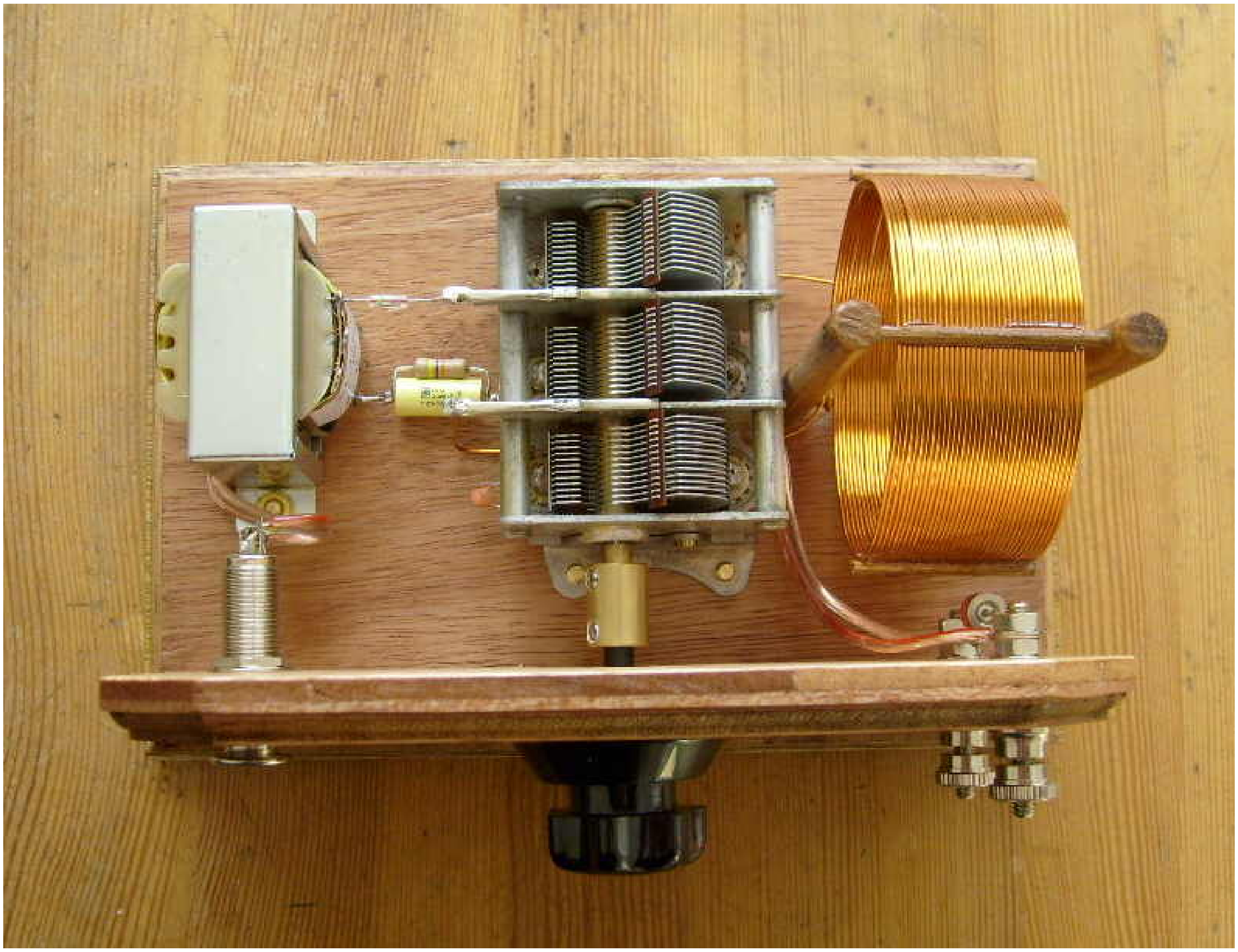
This receiver has a single tuned circuit, the Q factor of the tuned circuit is quite low.
The receiver can be used well for reception of local stations, for reception of distant stations it is less suitable.

I tried to give this receiver a nice "old-fashioned" look, the reception performance was in this design of less importance.
This receiver is for sale, I made a series production of these, and will build more on request.
This receiver is also for sale as do-it-yourself kit.
See the shop for more information.

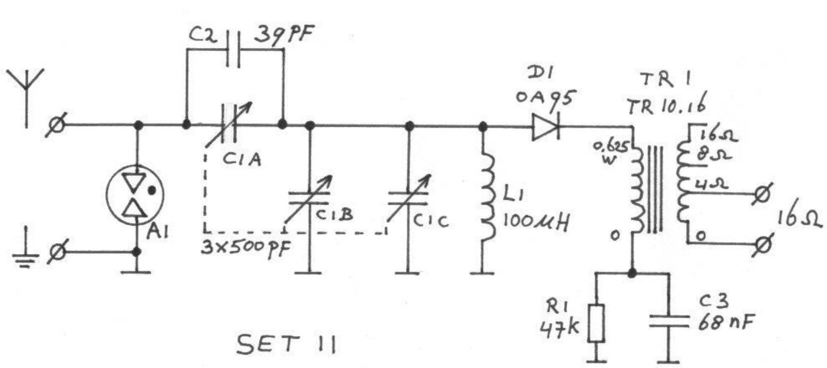


The front panel of the receiver.
On the left side the socket for the headphone.
In the middle the tuning knob.
On the right the connections for antenna (upper) and ground (lower).



Top view of the receiver.

Circuit diagram of receiver set 11



Circuit description.
The resonance circuit is formed by coil L1 and C1b and C1c (together 1000 pF).
Capacitor C1a and C2 provide the matching between antenna and tuned circuit.
The frame (rotor) of the tuning capacitor is carrying the RF signal, by this it is possible to tune simultaneously the tuned circuit (C1b and C1c) and the antenna matching (C1a).
Germanium diode D1 provides the signal detection.
Transformer TR1 is loaded with 16 Ω at its 4 Ω output, through this the input impedance increases from 16 kΩ to about 43 kΩ.
At the output a headphone of 2x 32 Ω can be connected, with the two speakers parallel, the impedance is 16 Ω.

Component A1 is a *gas discharge tube* (also called: *surge arrester*) with type number: N81-A90X.
The gas discharge tube protects the antenna input for too high voltages.

These high voltages can occur if the antenna picks up static charge from the air (especially occurs with long outdoor antennas from non insulated antenna wire).
As the voltage at the antenna is higher then 90 Volt, the gas discharge tube will start to conduct and short the high voltage to ground.
As soon as the charge has flown to ground, the conduction stops automatically.

Frequency range of the receiver.
Frequency range without antenna: 500 - 2500 kHz.
Frequency range with 10 meter antenna connected: 487 - 1860 kHz.
Both with and without antenna connected, the whole medium wave band can be tuned.

Q factor of the LC circuit (Without antenna and without diode connected):
600 kHz: Q= 83
900 kHz: Q= 81
1200 kHz: Q= 75
1500 kHz: Q= 65
The circuit Q is rather low, one reason for this is because the RF signal is in this design on the frame of the tuning capacitor.
Because the frame of the tuning capacitor is directly connected to the wooden bottom plate losses occur here.

You can find a complete building instruction op the following pages:

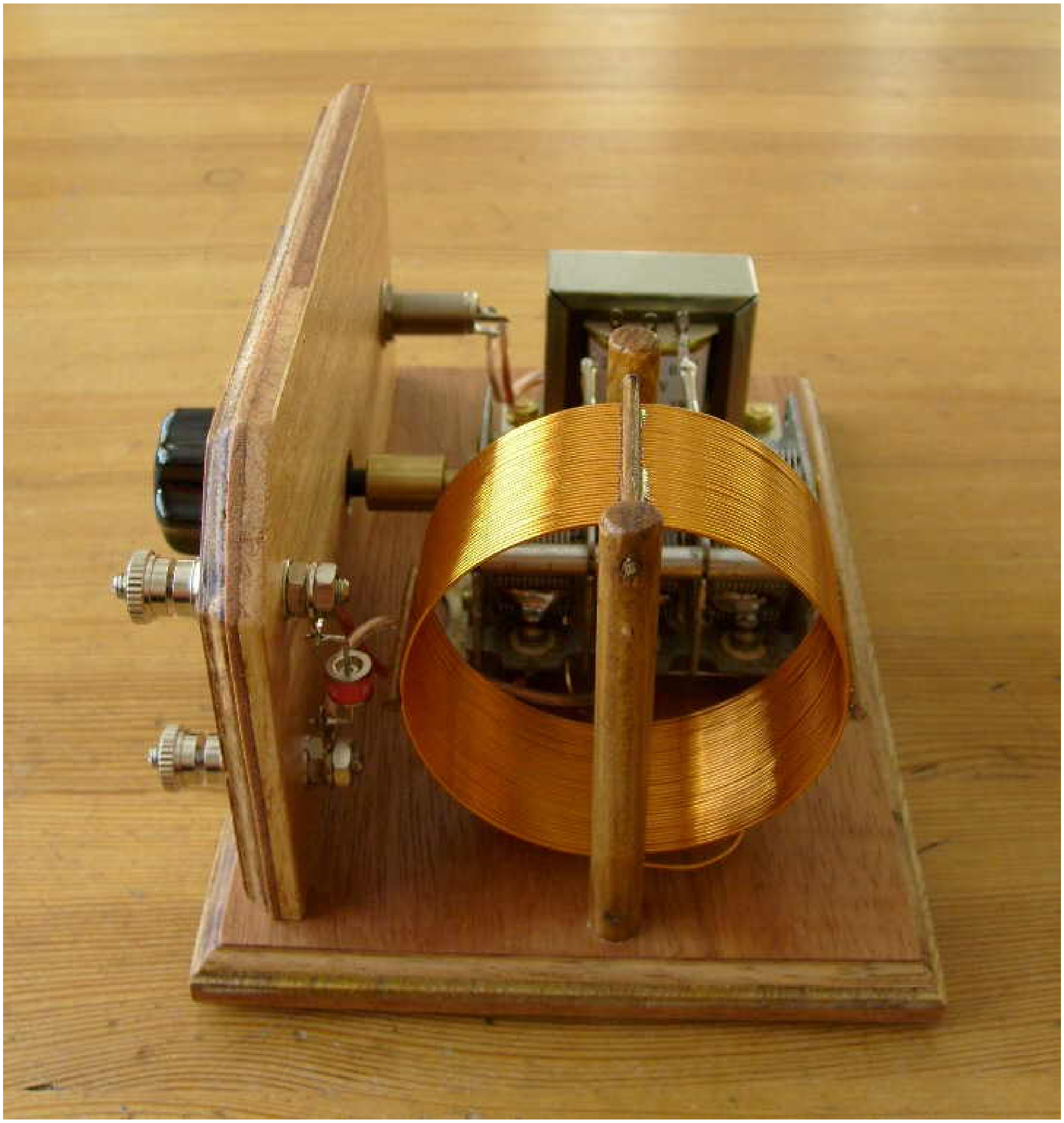
Step 1 Preparing the components

Step 2 Making the frame of the receiver

Step 3 Making the coil

Step 4 Placing the components

You will find here the part list of this receiver.



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Crystal receiver set 12

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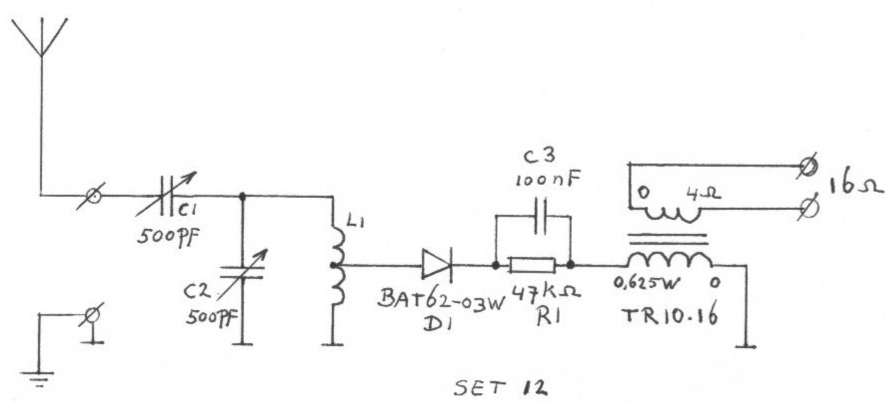
Set 12 is suitable for receiving local stations, which can be heard via a modern 2x 32 Ω headphone.
This receiver has two tuning capacitors.
One is for tuning, and one is for impedance matching between antenna and tuned circuit.



Circuit diagram of set 12

Tuning capacitor C1 provides a matching between antenna and tuned circuit.
C2 and L1 form the tuned circuit.
L1 consists of 12 meter litzwire 36x0,07 mm with a tap on 50 % (6 meter).
The coil former is made of a cd from which the shiny layer is removed.
The cd has 9 slots through which the litzwire is wounded.

The diode is a schottky diode.
The transformer has an input impedance of about 44 kΩ, when the receiver is loaded with 16 Ω.

The components in the receiver.

The Q factor of the tuned circuit, not loaded with the diode is:
600 kHz: Q=105
900 kHz: Q=108
1200 kHz: Q=95
1500 kHz: Q=84
Because of the quite low Q, this receiver is not so suitable for receiving distant stations.

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Dave's Homemade Tube Radios
SCHMARDER.COM

David's Duodecal Delight —

12AE10 Regenerative Radio

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Introduction

Hello honored visitor! Thank you for your visit. Today's radio is built with a *Compactron* tube. While the compactron was the big idea of some Wunderkind at GE in the early 60's, it has become the unwanted stepchild

of radio amateurs, restorers and audiophools alike. This means they are available very cheap, and hence has grabbed my attention

The Idea

I used to sell a lot of compactron tubes where I worked. For an old school guy like me, these were somewhat odd, with their 12 pin duodecal tube base. I never thought about building anything with them. I had seen magazine articles that used them to build small one or two tube radios. So now is my turn.

The Circuit

The center of this circuit is the 12AE10 compactron tube. Please download the data sheet from Frank's tubes (http://frank.pocnet.net/index.html) . Make sure to drop Frank an e-mail thanking him for his efforts. As a little tip, I would suggest saving anything you get from Frank's set to your hard drive. That way, when you want to see it again, you don't use the bandwidth again.

The 12AE10 is a dual section tube. One is a low power sharp cutoff pentode and the other side is a beam power audio pentode. As logic dictates, the first section is the regenerative detector, while the other section drives the speaker.

The circuit is not really unusual. The regenerative feedback is accomplished by a tickler coil in the cathode of the detector. A standard grid leak circuit offers grid rectification detection. The audio is recovered at the plate, after the signal travels through the LC filter. A 25k ohm pot controls the screen voltage on the detector, which controls the amount of regenerative feedback. The operation of this control is very smooth. You will have no problems setting that exact point just before oscillation for maximum sensitivity.

The power supply is a voltage tripler. It starts out with a "wall wart" transformer with an output of 24vac at 650 ma. This is part number ACTX-2465 available from All Electronics (http://www.allelectronics.com/) . The center tap is necessary to provide voltage for the tube heater, which requires 12 volts.

The full 24 volts ac then goes through a voltage tripler. The voltages ends up to be 80 volts dc under load. I have to tell you that I did have a lot of hum problems at first with this radio. I eliminated the hum by using more capacitors than I had expected. The B+ voltage is lower than I had hoped for, but there is enough to get moderate volume to the speaker. There is moderate hum when headphones are used.

The audio output transformer is the famous Bogen T725. While I had speculated that this would make a nice audio output transformer in small radios for years, this is my first time to try it. The problem is that the Bogen has a solid iron core, rather than a laminated metal core. This means that under moderate dc current flowing, the transformer core would become saturated. I decided to take a chance and I wasn't disappointed. It is probably true that a true tube audio output transformer would work better, this is a good way to go. I used the black and violet wires as the primary connections. This gave me the loudest sound.

The radio is tuned by a 540 pF capacitor. This is available from Leeds Radio (http://leedsradio.com) . It is really a dual section 270pF with a nice 2:1 vernier drive. That added with the 6:1 vernier reduction drive gives 6 full turns of the knob to tune end to end. You can use a smaller capacitor, such as a 410pF, but the bigger capacitor lets me tune part of the 160 meter ham band.

The main coil, also heavily involved with the tuning of this radio is wound on a HDPE spider coil form. The outside diameter is 3-½ inches (90 mm). The hub diameter is 1-¾ inches (45 mm). I used 40/44 litz wire to wind all the coils. There are 51 turns on my main coil tuned with the 540pF capacitor. Using a 410pF tuning capacitor, you should start with 55 turns. You can trim as you feel necessary to get the tuning range the way you want it. To provide the best isolation with the tickler, the inside of this coil goes to ground, while the outside goes to the grid leak circuit.

The tickler coil is on a 2 inch form (50 mm) with 1 inch hub. I wound 4 turns on this form. The tickler is mounted to the main coil at the center. The turns will need adjustment. You want good regeneration control through out the band. It is best to have as few turns as possible and still get the job done.

The antenna coil has 25 turns on a 2 inch diameter form with a 1 inch center. The antenna coil is connected to a 1/4 inch (6 mm) rod that passes though a panel bushing on the front panel. Two grommets (Thanks Mike Peebles) are used to hold the antenna coil on the shaft. Also, if someone starts turning the shaft instead of push pulling it, there won't be any pulling of the antenna coil wires. By pulling and pushing the rod, you can control the amount of rf that is picked up by the main coil. Some kind of front end level control is always necessary on a regen radio. This can be done mechanically, as I have done, or it could be a variable capacitor between the antenna and coil, or even a potentiometer. The number of windings on this coil may need to be adjusted, depending on your receiving conditions.

There is a LED that causes a blue circle to be shown through the white dial when the radio is on. It is not shown on the circuit, but involves a LED, rectifier diode and a 1000 ohm resistor, all wired in series and connected to the power switch. A nice little touch.

Construction

This radio is made out of (surprise surprise) Garolite®! It is made the same way as many of my other project panels and chassis. After the panel is connected to the chassis with a pair of small angle brackets, then the hole can be found for the vernier. I put a pointed piece of metal on the end of the capacitor and make my mark on the panel. A pencil connected to the capacitor shaft would also work. Then the vernier holes are drilled. After that, the capacitor mounting holes can be marked and drilled.

Then mark and drill the holes for the controls. After that, the standoffs (made from Delrin at 2 inches long) can be mounted. Those are all the critical holes. Now find room on the chassis for everything else. Don't forget the solder lug mountings. You will need a couple of holes at the front of the chassis so the wires from the controls can pass down under.

My panel is 6-½ x 9-½ inches (16,5 x 24 cm) and the chassis is 5-½ x 9-½ inches (14 x 24 cm). The reason for this size is that the Garolite® comes in 12 inch wide sheets. The width was made to match the piece of wood that I had previously finished.

Be prepared to reverse the tickler winding leads if the radio fails to go into oscillation. Myself, I just connect them and see if it is right or not. I seem to get it right around 50% of the time.

Conclusion

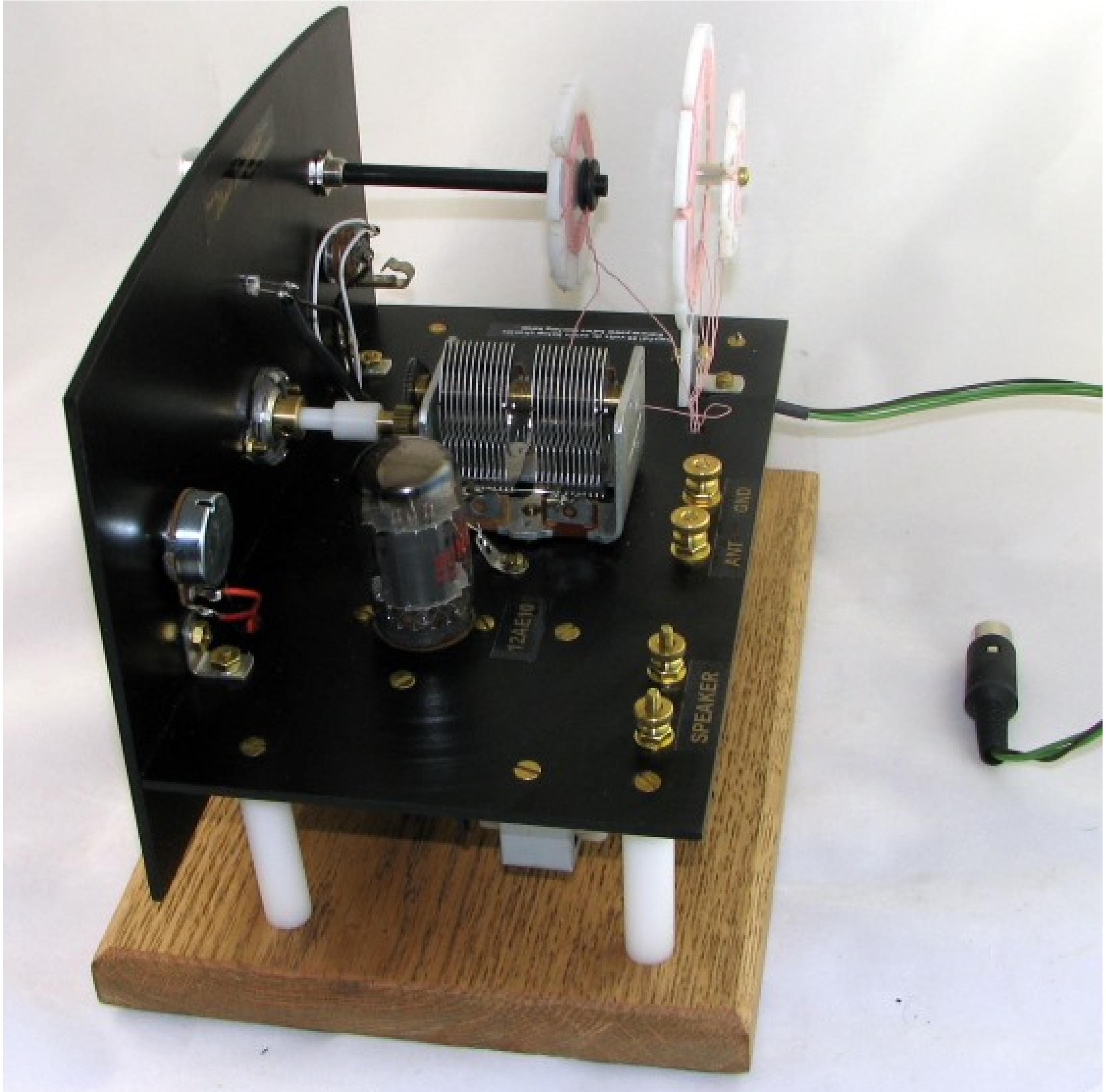
This is a great project for the intermediate builder to make. I caution you that the 80 volts, while not particularly dangerous, can cause discomfort if you grab on to it. Make sure the capacitors are discharged before working on this set.

The performance is good with moderate volume. It sure isn't your kid's ghetto blaster, but will give you hours of listening pleasure on a radio that you built!

73 and happy radio building ~ Dave, N2DS


12AE10
SPEAKER
ANT
GND


12AE10
SPEAKER
GND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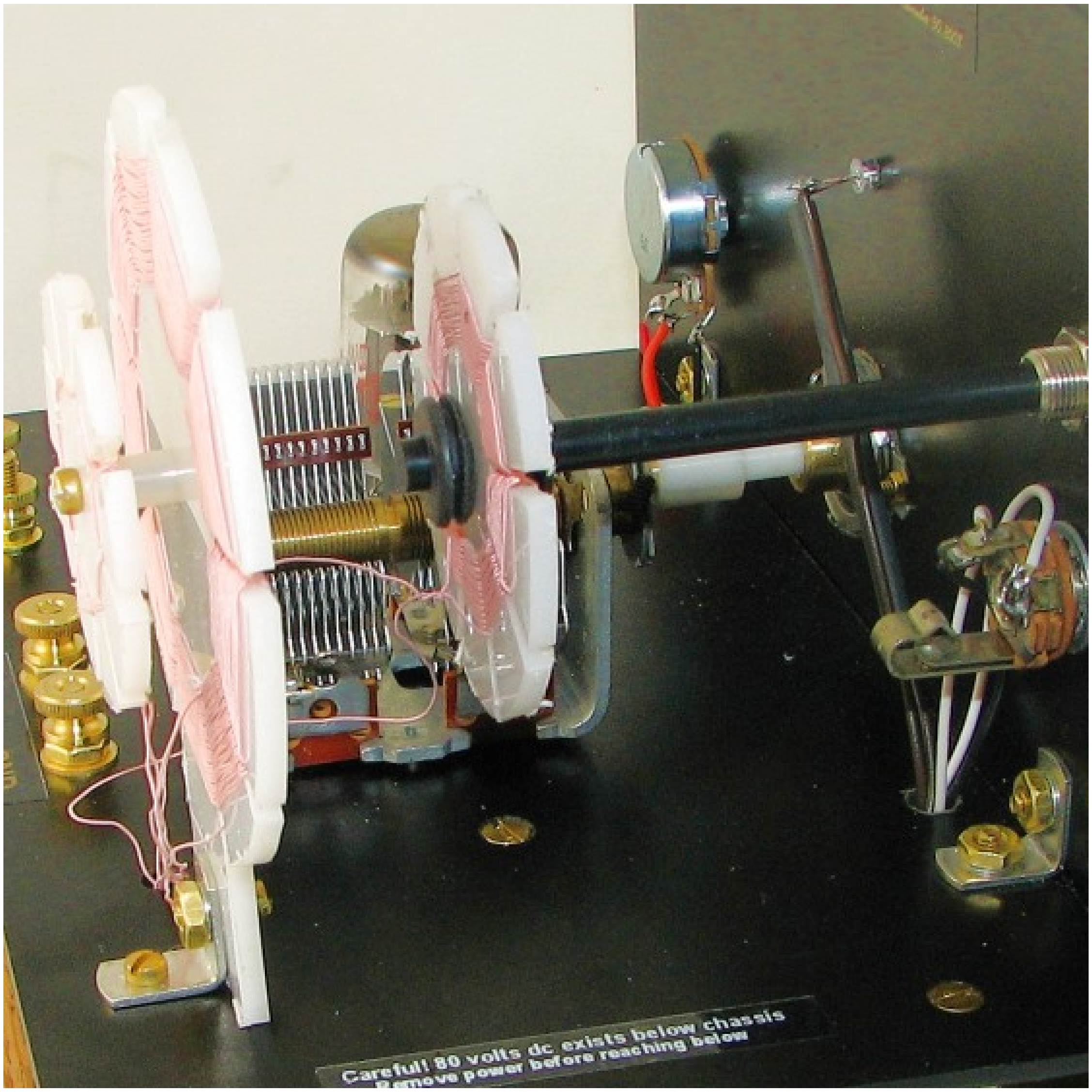
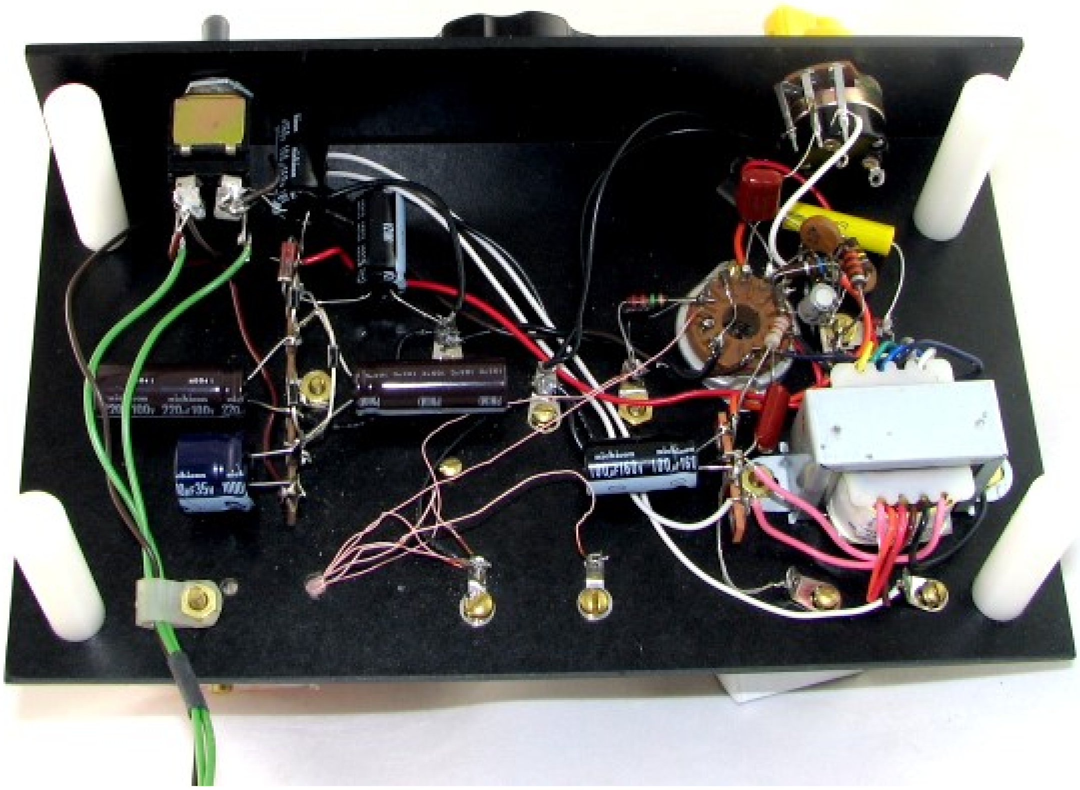
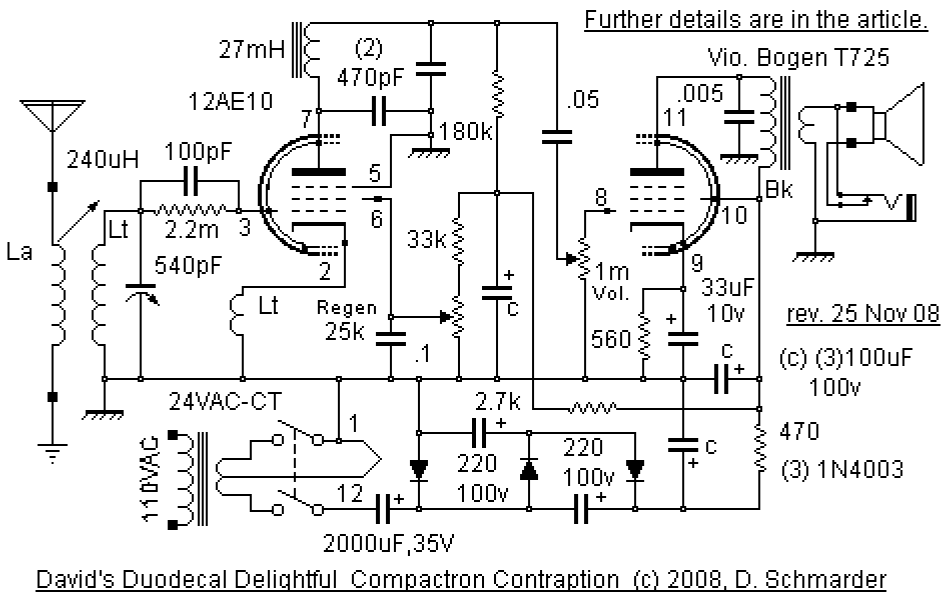


Coil Close-up, Tickler, Main Coil and Variable Coupling.



Under the Chassis View

24VAC-CT Power Supply



Schematic

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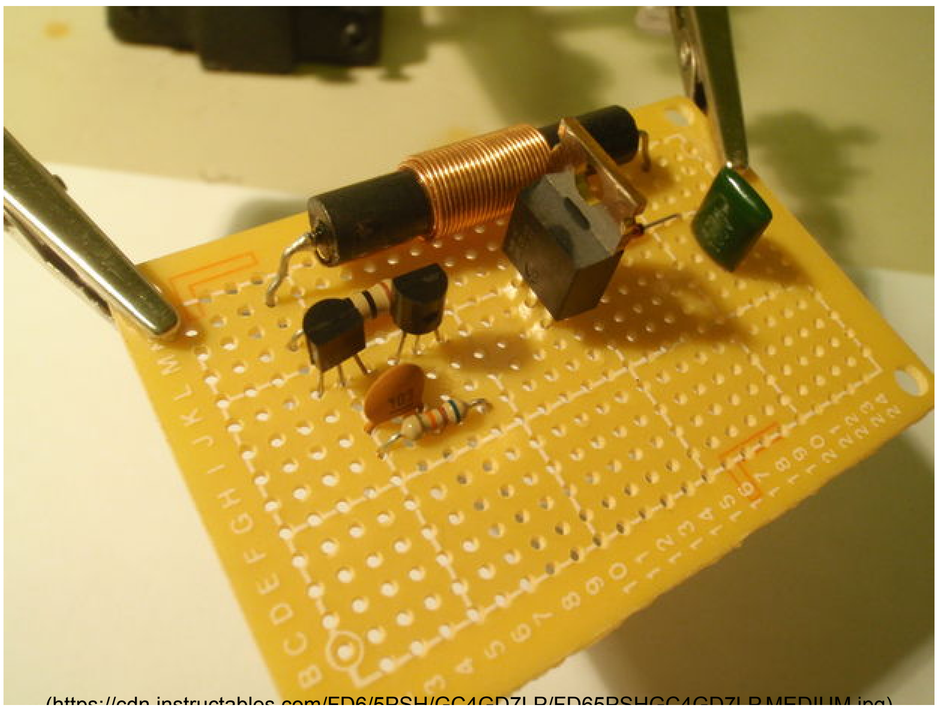

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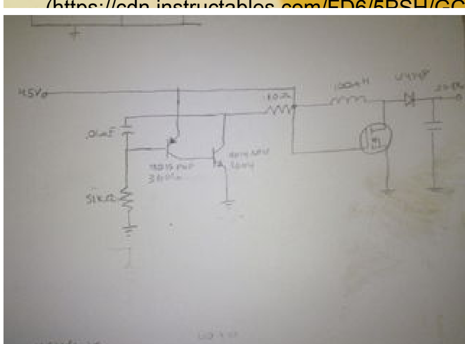

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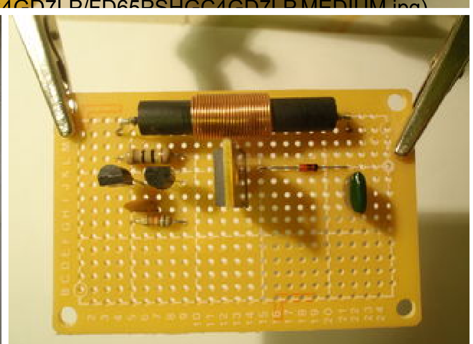

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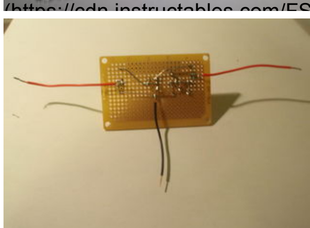

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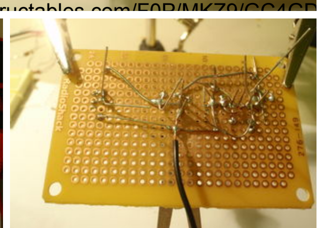

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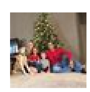

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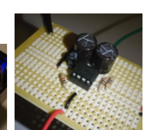

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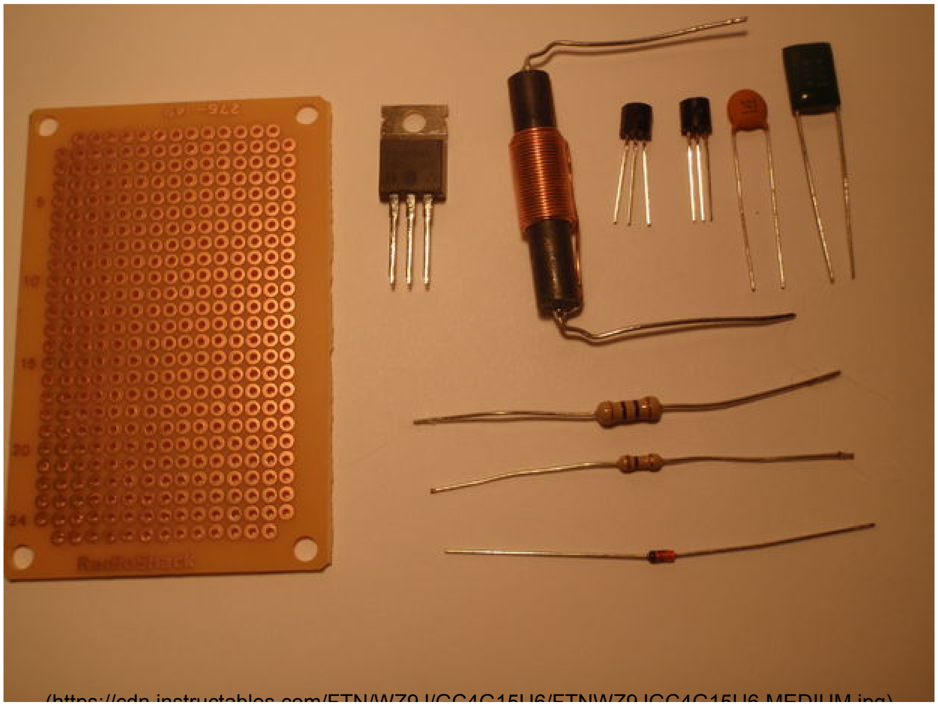
(/id/Full-Spectrum-Flashlight/)



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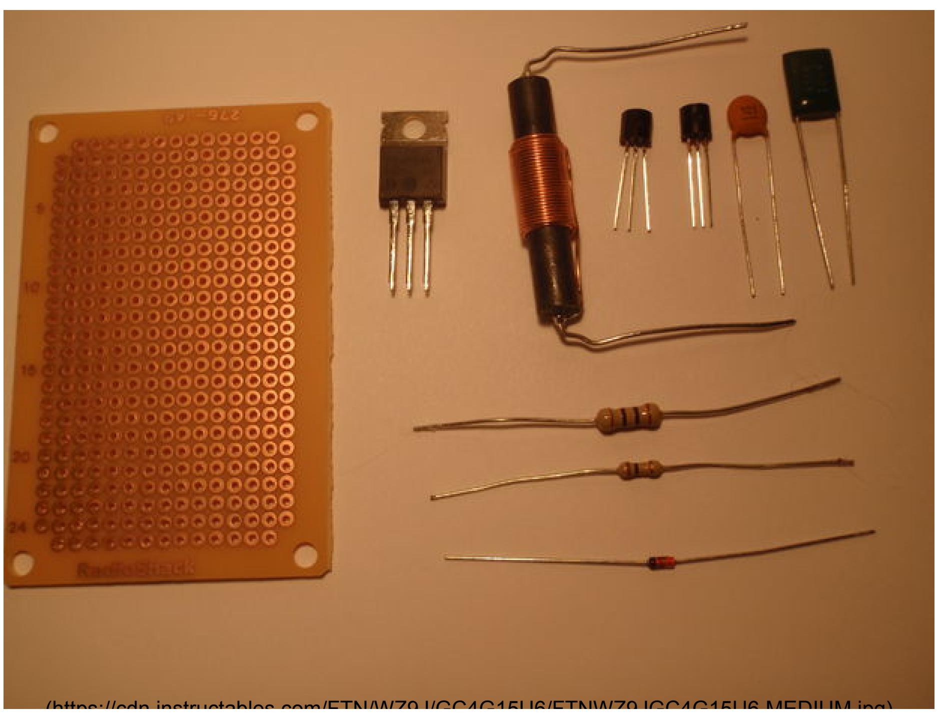
My first intention was to design a DC Voltage boost converter to convert 3vdc to 5vdc so that I could power my iPod or any other device requiring 5 volts to charge. I read about oscillation circuits and boost converter circuits and combined the two. My results were staggering when I was able to convert 4.5 volts to over 100 volts by accident. I decided to post an instructable for this instead, for now. If you have any tips to increase the efficiency or output current please comment below, I appreciate any suggestions.

Step 1: Obtain Parts



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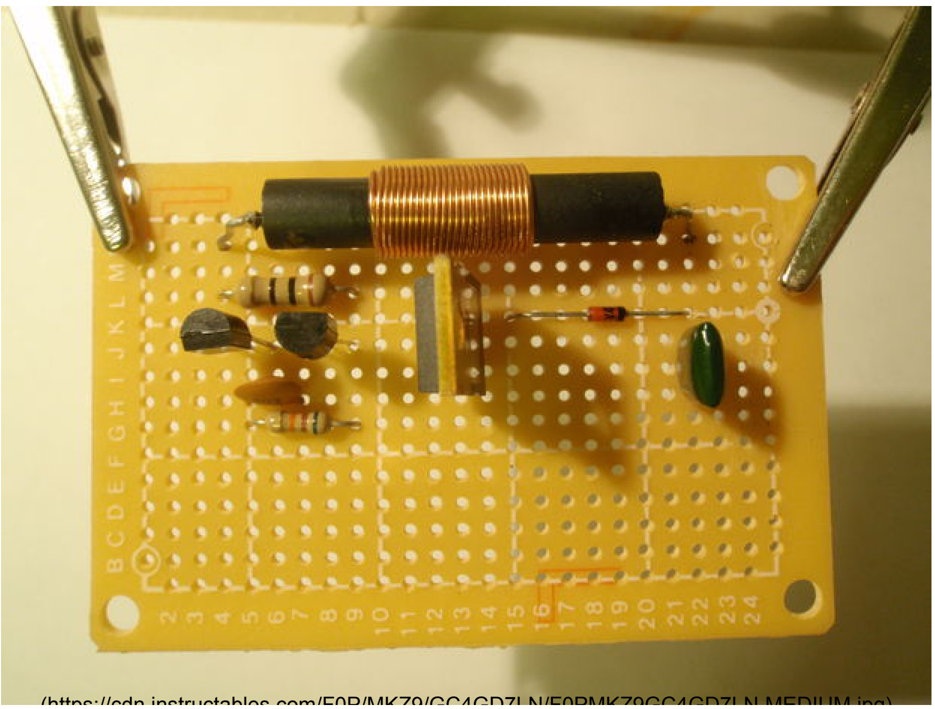
All components can be found at RadioShack.

PCB
3 X 1.5 volt Battery Holder

L1	RF Choke	100 micro Henries
R1	Resistor	10 Ohms
R2	Resistor	51K Ohms
Q1	PNP Transistor	2N3906
Q2	NPN Transistor	2N3904
Q3	Power MOSFET	IRF510
C1	Capacitor	.01 micro Farads
C2	Capacitor	.047micro Farads
D1	Diode	1N4148

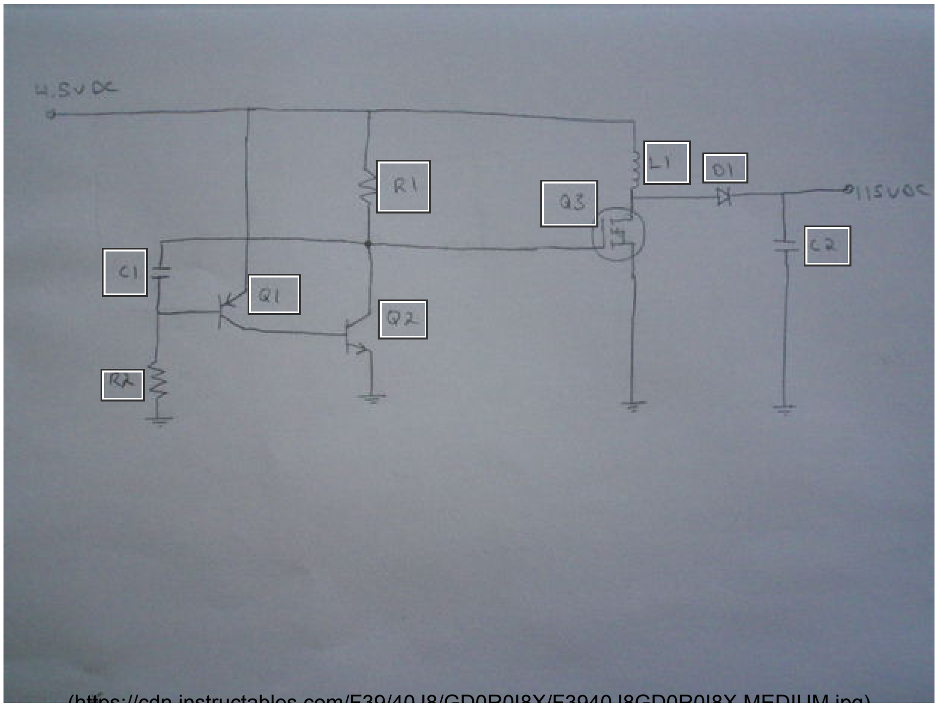
Step 2: Place Components



(https://cdn.instructables.com/F0B/MKZ9/GC4GD7LN/F0BMKZ9GC4GD7LN.MEDIUM.jpg)

Arrange components as you see here or as close as possible.

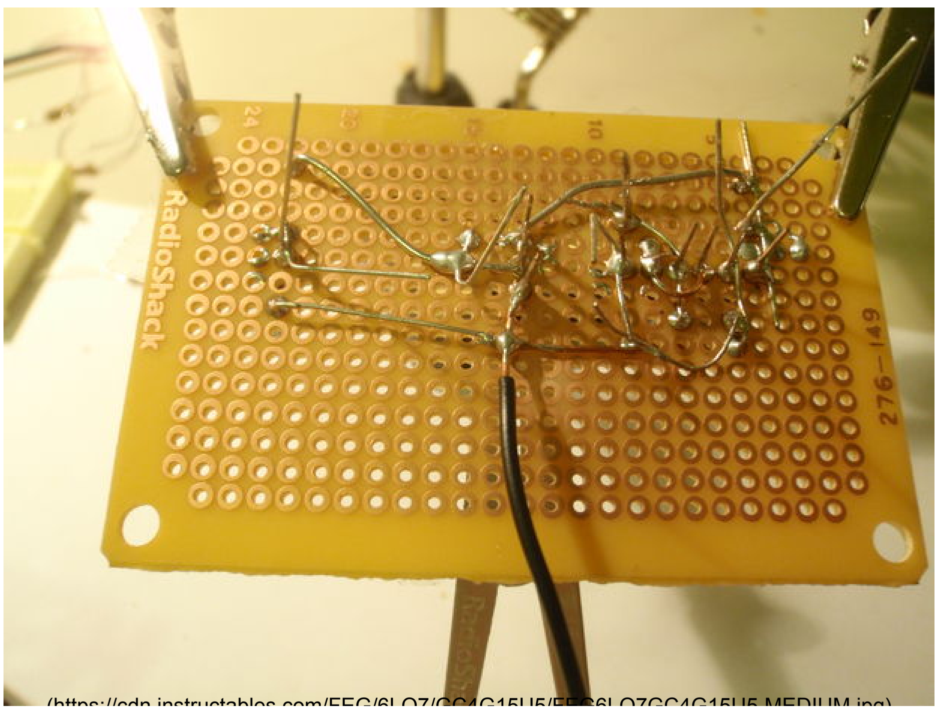
Step 3: Observe Diagram



(https://cdn.instructables.com/F39/40J8/GD0R0I8X/F3940J8GD0R0I8X.MEDIUM.jpg)

Look through the wiring diagram to see what components need to be connected to what prior to soldering.

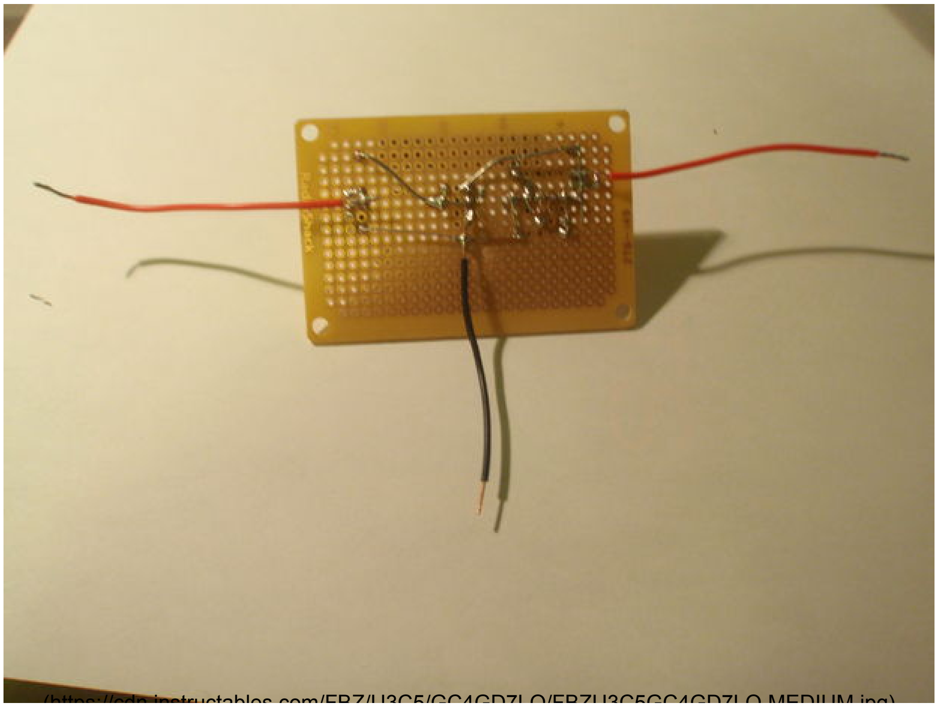
Step 4: Solder Components



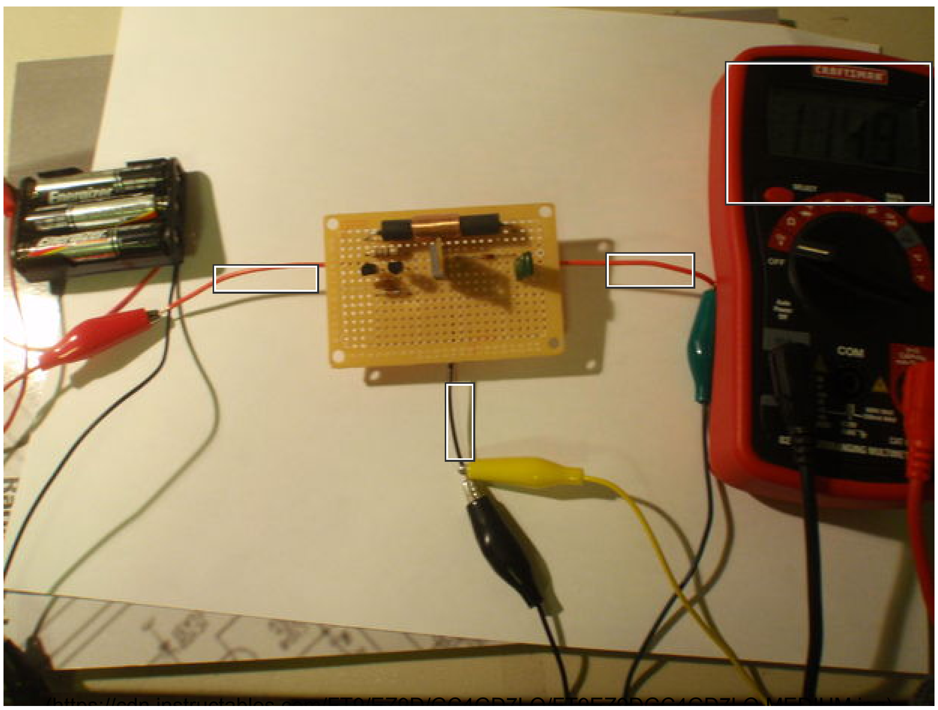
(https://cdn.instructables.com/FEG/6LQ7/GC4G15U5/FEG6LQ7GC4G15U5.MEDIUM.jpg)

Solder components carefully to ensure there are no shorts, also ensure all connections are made at all points.

Step 5: Clean Up and Test



(https://cdn.instructables.com/FBZ/U3C5/GC4GD7LO/FBZU3C5GC4GD7LO.MEDIUM.jpg)



Trim component leads and clean solder joints. Be sure to double check connections to make sure a connection isn't left out. Hook up battery terminals and multimeter and see what you've got!!!

Comments

We have a be nice comment policy.
Please be positive and constructive.

I Made it! Add Images Post Comment

Tanmay Deuskar (/member/Tanmay+Deuskar/) 2017-10-16 Reply

Hello,

I'm interested in making this circuit however I don't have a RF choke inductor. Can a regular one work? Also can I use a bc-547 or a 2n2222 instead of the NPN transistor you used?

Thanks

JindřichV (/member/Jind%C5%99ichV/) ▸ Tanmay Deuskar (/member/Tanmay+Deuskar/) 2017-10-25 Reply

Sure, 2N2222 is a better option for Q2 because its current rating (600 mA) is more adequate for the 10 ohm resistor (current up to 400 mA) than 2N3904 (max Ic "only" 200 mA).

gsmq2016 (/member/gsmq2016/) 2016-03-05 Reply

I would like to convert 18VDC 8A to 100VDC 2.5A

shomas (/member/shomas/) ▸ gsmq2016 (/member/gsmq2016/) 2016-05-18 Reply

Even at 100% efficiency, no one can boost 18v@8 amps (114 watts) to 100v@2.5 amps (250 watts): Laws of physics, as in energy can neither be created or destroyed.

Marcov68 (/member/Marcov68/) ▸ shomas (/member/shomas/) 2016-08-22 Reply

At 219% efficiency it should be possible ;-) 95% is already possible so why not exceed that. The world keeps on progressing.

shomas (/member/shomas/) ▸ Marcov68 (/member/Marcov68/) 2017-09-01 Reply

True efficiency > 100% is like a unicorn. it is nothing more mythical and does not exist. Sure, some times we have apparent efficiency that are over 100% but the extra energy comes from something else and was not not accounted for in the apparent figure. thus the difference between true and apparent efficiency

---

Edward Sun (/member/Edward+Sun/) ▸ Marcov68 (/member/Marcov68/) Reply 2016-10-22

You realize that's not possible. Energy can't be created nor destroyed. Even 100% efficiency is not possible due to some energy being radiated out of the transistors as heat.

---

shomas (/member/shomas/) ▸ shomas (/member/shomas/) 2017-03-28 Reply

I have to correct myself, I was assuming continuous output. Watts is a measure of power, not energy. If one needs to get more power then what is put int, it could be done by storing and releasing power quickly over a shorter time. One way this can be done with pulse width modulation the output into on and off duty cycles. spending different amounts of time in each.

Over the course of an hour, a source voltage of 18v and a load that draws 8 amps will source 114 watts for each second of that hour. sourcing 114 watts * (3600 seconds, 60 seconds in a minute * 60 minutes in an hour) = 410,400 watt seconds(watt second is an expression of energy = joules). With an impossible 100% conversion, 410,4000 watt seconds of energy / 250 watts output means you can deliver 250 watts for just 1641.6 seconds. That works out to about 27 minutes and 21.6 seconds. In a world with perfect efficiency using pulse width modulation, one could convert 114 watts to 250 watts with a 45.6% on duty cycle on his output, and a 54.4% off duty cycle.

Travour776 (/member/Travour776/) ▸ shomas (/member/shomas/) Reply 2017-02-04

Agree

BrianB405 (/member/BrianB405/) ▸ gsmq2016 (/member/gsmq2016/) Reply 2016-12-29

First you will need to setup a tesla coil at 8hz and a very large capacitor (big vat of veg oil). This will be giving you that extra efficiency you unknowingly seek ;p

Next you will need to go ahead and setup a microwave ray in order to excite helium plasma into their "boson" particle state. Go ahead and hook this up to the big vat o' veg oil. Please note that the built up helium boson waves will need to be calmed in order to extract the energy in 'physical' form.

Note that these are alpha particles. Do not touch!

Next you will want to hook up 54 and a half (just chop 'er with a butcher knife) "C" batteries in series. This will give you that 82 volt boost and well as compensate for your missing 106 watts. Should give you a good 4 minutes of power.

Finally, sit back and enjoy!

jhonyFu256 (/member/jhonyFu256/) ▸ gsmq2016 (/member/gsmq2016/) Reply

2016-09-07

really dude!!! you made my day t hank you ;)

jayas15 (/member/jayas15/) 2017-08-18 Reply

can we increase the power of the supplied power?

if yes help me in solving it

chakrabarttyaditya (/member/chakrabarttyaditya/) 2017-08-14 Reply

How to convert 6V to 12V by this process. Please help me out.

IamNoob (/member/IamNoob/) 2017-07-11 Reply

I know this is stupid question but can I put 5VDC instead of 4.5VDC?

Andrea Antonio Gallo (/member/Andrea+Antonio+Gallo/) 2017-05-01 Reply

Congratulations on the job, I would need a 12V to 80V, you can help me.

Lima79 (/member/Lima79/) 2017-03-03 Reply

I don't know where was i(: how did i missed this. Still having problem with my 45-0-45VAC transformer, still having a short in the primary coil winding, no idea. I think it will be better building this one instead if i can get a 45-0-45VDC, anyways thank you good brother for the share.

Muhammad Asim khan1 (/member/Muhammad+Asim+khan1/) 2016-11-02 Reply

Hi, I need your help..

Can I DESIGN HIGH VOLTAGE DC POWER SUPPLY (50KV) from 220 V using boost converter....??

Kindly Guide me....

WasimA22 (/member/WasimA22/) 2016-09-28 Reply

1- Can this circuit convert 12v & 22amp to 100v and 2.64amp without any heat sink??? Please answer if you are confident

2- and how to step down. This circuit is really simple

3- Is this tightly regulated voltage?

Porkchop559850 (/member/Porkchop559850/) 2016-03-15 Reply

Need to step up a 12v 300amp power supply to a 18v 300amp power supply without changing the power supplies inside it

shomas (/member/shomas/) ▸ Porkchop559850 (/member/Porkchop559850/) 2016-05-18 Reply

Even at 100% efficiency, no one can boost 12v@300 amps (3600 watts) to 18v@300 amps (5500 watts): Laws of physics, as in energy can neither be created or destroyed.

jhonyFu256 (/member/jhonyFu256/) ▸ shomas (/member/shomas/) Reply 2016-09-07

seen so many posts like this today!! I am just staggered because in my mind it felt like this was a piece of knowledge everybody possessed!!

BETTINGT (/member/BETTINGT/) 2016-07-19 Reply

what should i change to make 1.5v to 5v booster

BETTINGT (/member/BETTINGT/) 2016-07-19 Reply

what should i change to make 1.5v to 5v booster

alexmd6279 (/member/alexmd6279/) 2016-06-05 Reply

How can i boost 5VDC (from Arduino microcontroller) to 12VDC(motor)

01MadMan14 (/member/01MadMan14/) ▸ alexmd6279 (/member/alexmd6279/) 2016-07-17 Reply

If this is still relevant, instead of using the Arduino's output of 5v, I would wire a DC-to-DC step-up converter directly from the power supply you're using to power the Arduino (9v Battery?). This should be more efficient than trying to step-up from 5v. There are a few good converters on this website and many more on others. Then you would wire the motor through a transistor or similar system and use the digital signal from the Arduino to control the transistor, thus powering the motor. Another option is a motor driver module, which can also be made.

If this goes beyond your current situation, it is possible to buy both converters and motor drivers/controllers. It would reach the same effect in a more modulated way, but you should be reasonably sure that it would work.

If this is a fixed object, you could also look for an old computer power supply, from which you could power both the Arduino, motor, and pretty much anything else, without worrying too much about amperage. These things are not terribly mobile though and maybe a bit overkill at time... Nevertheless, convenient.

kwphysics (/member/kwphysics/) 2016-06-11 Reply

I've been studying this circuit for a couple hours now trying to understand how it works. I understand that the input DC is modulated to run the gate on the MOSFET and rock that inductor, but how is the coupled transistor pair (PNP/NPN) doing that? I imagine an astable multivibrator configuration would do the same thing, but how does this equal that? Any links or references would be very much appreciated!

sinas1 (/member/sinas1/) 2014-11-06 Reply

How can i boost 9VDC-350ma to 9VDC-2ampre

aji hanif (/member/aji+hanif/) ▸ sinas1 (/member/sinas1/) 2015-12-15 Reply

you can reduce resistance, since V=I*R, so if you reduce resistance the current will go further than 350mA, the way you can reduce resistance is by...well removing resistor, or by make your resistor parallel with other resistor. since battery or other voltage source (real life) have internal resistance, you can parallel it with one and another (but not all voltage source can be parallel with one and another) CMIIW

shomas (/member/shomas/) ▸ aji hanif (/member/aji+hanif/) 2016-05-18 Reply

Can not get more energy out than is put in. Laws of physics and all. His units were given in volts and amp, but it were possible to build a booster to his specs, then for each second it runs it would create more energy than it consumes.

aji hanif (/member/aji+hanif/) ▸ sinas1 (/member/sinas1/) 2015-12-15 Reply

you can reduce resistance, since V=I*R, so if you reduce resistance the current will go further than 350mA, the way you can reduce resistance is by...well removing resistor, or by make your resistor parallel with other resistor. since battery or other voltage source (real life) have internal resistance, you can parallel it with one and another (but not all voltage source can be parallel with one and another) CMIIW

carroty (/member/carroty/) ▸ sinas1 (/member/sinas1/) 2015-07-22 Reply

Next Level impossible bro. use less resistance in your circuit and you will get more amps out of your battery or whatever you need to do.

valveman (/member/valveman/) ▸ sinas1 (/member/sinas1/) 2015-04-21 Reply

You can't get more power out than you put in.

Jimmacle (/member/Jimmacle/) ▸ sinas1 (/member/sinas1/) 2014-11-09 Reply

You're trying to change 3.15 watts (V*A) of power into 18 watts of power which is impossible. You'll need a power source that can supply at least 18 watts of power.

aalejo (/member/aalejo/) 2015-01-06 Reply

I have some question it is the thing. Can my power amp rates 16 volt can power it by your design??? Pls answer me

aji hanif (/member/aji+hanif/) ▸ aalejo (/member/aalejo/) 2015-12-15 Reply

it might can power it, however the noise from this circuit will ruin your music though . im suggesting you're using more that 16V then using linear regulator, idk though, im building my diy amp and it was very sensitive to noise

shomas (/member/shomas/) ▸ aji hanif (/member/aji+hanif/) 2016-05-18 Reply

capacitor inductor capacitor (pi filter) will clean up a lot of noise. The second capacitor needs very low ESR rating for best performance from the filter

mikee212 (/member/mikee212/) ▸ aji hanif (/member/aji+hanif/) 2016-03-19 Reply

In are if constant line? Dozens! Look more in wire two. Aloe vera.

Source: stairs.

MohamedA210 (/member/MohamedA210/) 2016-05-04 Reply

please i made this circuit but it can only boost high voltage what if i need to boost a small voltage like that is out of a paltier???

shomas (/member/shomas/) ▸ MohamedA210 (/member/MohamedA210/) Reply 2016-05-18

Your issue is two fold. One, by itself the voltage is too low. bump it up with more in series before you boost it. two, the power produced is extremely low and such that drawing even a modest amount of current drops the voltage to unusable levels. You need consider this last point when pairing it with a load, because your not going to pull 5 watts from a device that produces less than a watt.

mr electro (/member/mr+electro/) 2016-05-17 Reply

You can greatly increase the efficiency of a boost converter by using a fast switching Schottky diode like a 1n5711. If it is a low voltage low current application, you can even use a Germanium diode such as a 1n34 or 1n60 as I did in my Instructable (Solar Powered Battery Charger) a few months ago. The increase in efficiency is due to the lower voltage drop across the Schottky or Germanium diodes.

ganban (/member/ganban/) 2016-03-28 Reply

I want to convert 9v to 5v with the ratio of 4.5 amp.How can i convert it,can you please give me instructions.

J0SHUANIC0LL (/member/J0SHUANIC0LL/) ▸ ganban (/member/ganban/) Reply 2016-04-14

All you need is a 5V regulator, 4.5 amps is lot though, you need a 25 watt 5V regulator, or 25 i watt 5V regulators.

ChantalL7 (/member/ChantalL7/) 2016-04-09 Reply

how much is the amperage on this design

pityukecske (/member/pityukecske/) ▸ ChantalL7 (/member/ChantalL7/) Reply 2016-04-09

200 mA maximum output current. 1N4148 isn't a very good choice for a power converter.

---

ganban (/member/ganban/) 2016-03-28 Reply

I want to convert 9v to 5v with the ratio of 4.5 amp.How can i convert it,can you please give me instructions.

ArmandC7 (/member/ArmandC7/) 2016-03-23 Reply

is it possible to covert say 50-100mv to 4 or 5v?

MaseM8 (/member/MaseM8/) 2016-02-20 Reply

I need to convert 12v 7.2A lead acid battery to 450V, to charge a 450V 15000uF cap. How can I do this?

Grey_Apple (/member/Grey_Apple/) ▸ MaseM8 (/member/MaseM8/) Reply 2016-03-01

Quick answer: With a step up booster, like what OP made, but stronger.

---

pallc (/member/pallc/) 2016-02-26 Reply

I was wondering if, with a diode circuit and large enough capacitor and maybe an LED to turn on once capacitor is charged ran after a 5V 1A or 2A USB output that has 200000mAh capacity battery source, I could make a 12-14V output to use as an emergency car battery starter with the car battery that is clamped in parallel? If not, how would you make such a device? Was thinking of another back-up emergency use for the 200000mAh solar power battery bank: http://www.ebay.com/itm/200000mAh-Solar-Power-Bank... (http://www.ebay.com/itm/200000mAh-Solar-Power-Bank-Charger-Battery-Backup-Galaxy-Iphone-US-SELLER-NEW-/111783191331?hash=item1a06cc2323:g:nrIAAOSw3ydV4UDC)

Thanks in advance and awesome instructable!

---

purushoathn (/member/purushoathn/) 2015-10-16 Reply

how can i convert 100mv to 6v

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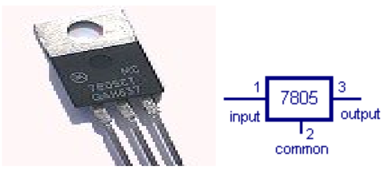
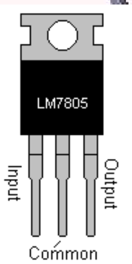
DC-DC converter, switching regulator using LM2576, LM2575 and more.

Written by Lim Siong Boon, last dated 08-Dec-09.

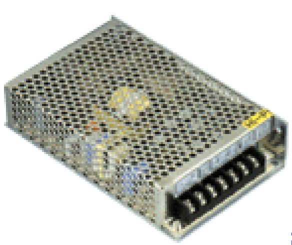
email: mail@siongboon.com
website: http://www.siongboon.com

Kit Research History

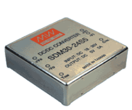




LM7805, TO220 package



SD-50A-5



SDM-30

PMA8811SF

UT70A

Power Supply Design for electronic circuit

A dc-dc regulator/converter or another name known as buck regulator or switching regulator, provides stable regulated output voltage to supply electronic circuits. Schematic, PCB layout and component list are available on this page.

LM2576 circuits perform same function as the commonly known voltage regulator LM7805 from National Semiconductor. The 7805 voltage regulator dissipates a lot heat. The higher input voltage, the more heat is generated. The extra input energy is converted to heat, keeping the output voltage regulated at 5V.

LM78XX series is available to regulate 5, 6, 8, 9, 12, 15, 18, 24V. If you want the output voltage adjustable, there is also a adj model. For -negative voltage supply, you can use LM79xx series. These regulator is able to support up to a maximum of 1A current rating.

LM7805 IC requires input voltage to be higher than output in order to regulate the output voltage. Input voltage needs to be at least 7V (up to a maximum of 20V) in order for LM7805 to regulate at an output of 5V. It is advisable to supply a voltage input range from 7.5V to 10V. Any higher input voltage is consider inefficiency, generating a lot of heat.

A switching mode power supply such as LM2576 dc-dc converter, uses switching control to reduce the input dc voltage on average. This is equivalent to a lower input voltage resulting in minimum heat dissipated. The control results in better regulated output, less energy wasted through heat and the use for high current application. Nowadays dc-dc converter are getting smaller and comes in the TO-220 package too. You can simply change your LM7805 to dc-dc converter without any change in your design.

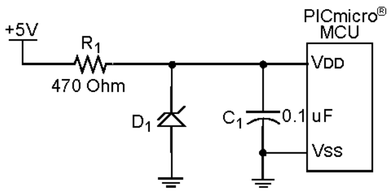
The first commerical module I tried is the SD-50A-5 from Meanwell rated at 5V 10A. It is very good and easy to use. However it is very big and bulky. If size is a constraint, you might consider the model SDM-30. It is able to handle up to 5V 5A and is a lot smaller than SD-50A-5. However it generates a lot of heat through its metal casing.

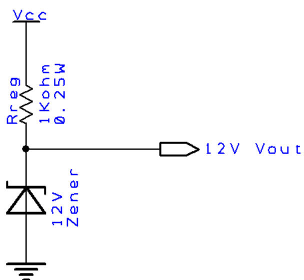
The best dc-dc I have tried before is PMA8811SF from Ericsson. It is by far the most compact (smaller than SDM-30) and most efficient dc-dc. Heat is also dissipated through it ceramic package, however it does not scalded your finger as much as SDM-30 do. The IC package is surface mount however soldering is relatively easy because the IC leads are quite broad. It is rated at output 5Vdc 16A and generate far less heat. Each pieces cost about S$60, a lot more than the other converter model.

Through some research, I get to learn about commercial standard dc-dc IC that perform with only a few external components. The following article discuss on LM2576 IC with rating up to 5V 3A. LM2576 is one of the dc-dc

Various type of voltage regulator design

a) Zener diode voltage regulator.
Suitable only for very low power application.





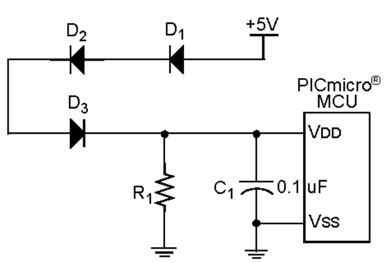
For Vcc 24V
- Zener (Vout) = 12V 240mW, Iout(max) = 20mA, Rreg = 600ohm 240mW
- Zener (Vout) = 12V 120mW, Iout(max) = 10mA, Rreg = 1200ohm 120mW
- Zener (Vout) = 5V 100mW, Iout(max) = 20mA, Rreg = 950ohm 380mW

For Vcc 12V
- Zener (Vout) = 5V 100mW, Iout(max) = 20mA, Rreg = 350ohm 140mW
- Zener (Vout) = 3.3V 66mW, Iout(max) = 20mA, Rreg = 435ohm 174mW

Refer to the following website to compute zener, resistor value for a required Vout/Iout.
http://www.reuk.co.uk/Zener-Diode-Voltage-Regulator.htm

b) 3 rectifier diodes as voltage regulator.

Suitable only for very low power application.



c) Using voltage reference TL431 as a voltage regulator.

This is a very simple and useful adjustable voltage regulator. If the load is <100mA, this is a very attractive solution. For 5V output, R1=R2=10Kohm. TL431 datasheet.

IC product range from National Semiconductor. There are also various brand of dc-dc regulator IC available.

The interfacing of most dc-dc IC requires the use of inductor. This is the case for LM2576 too. Try sourcing your local electronics shop for one if possible. I am not stopping you to make your own inductor. Just that making your own inductor takes up time and it is very likely to cost you more than what a shop might be selling.

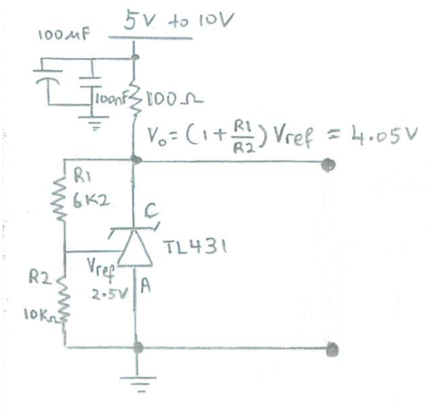
If you are interested in making your own coil, you might interested in this website, http://www.skylab.org/~chugga/mpegbox/coil/. The aurthor Jeff Mucha had demonstrated a simple and creative way to make inductive. One Long screw, 2 board flat washer, 2 nut, 1 ring spacer, glue, and XXX is all the tools that is require to make your own air core inductor. It is really interesting.

More article: home brew your own inductors

Jens Moller has contributed a program which generate a table of information for building air core inductor. Simply input the inductance value you need, the program will display a table containing the wire coil height radius and number of turns required. You need not have to understand formula to make your own inductor. Take a look at the following website, http://www.colomar.com/Shavano/inductor_info.html

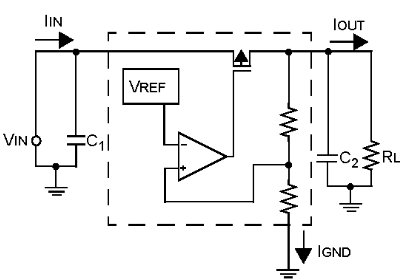
A greenhorn when I first attempt to use inductor. It is a tough job building circuits using inductor. I do not have proper equipment to measure the inductor on hand. Never able to find out the inductance value I have. Fortunately, there is this inductance measurement product selling at an affordable price. UT70A from Uni-Trend Technology. It also function as a multi-meter, and can be used to measure voltage, current, etc... . Even with an inductance meter, it is not a easy task to measure inductance accurately.

Other reference:
The practical basic of building a power supply.
- The Power Supply.pdf
http://www.talkingelectronics.com/projects/ThePowerSupply/Page79PowerSupplyP1.html



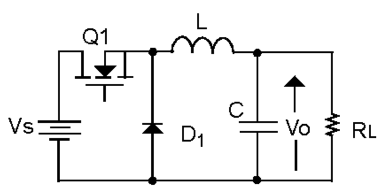
d) Linear voltage regulator.

Suitable for application that requires low noise.



e) Switching voltage regulator.

Suitable for application that requires high power.



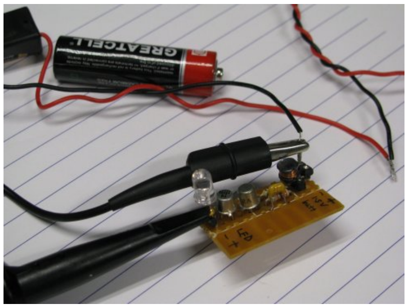
Circuit diagram taken from,
MICROCHIP

2009-09-13 dc-dc step up, LED driver using 1.5V alkaline battery

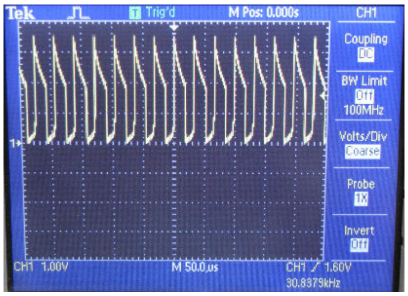
The simplest DC-DC step up converter I have done. Typical LED requires about 2V to operate. This ciruict is able to drive the LED from a 1.5V battery. The transistor forms the oscillating circuit generating pulsing

output. Although the output is pulsing, we can't actually see it on the LED, as the switching is quite fast.

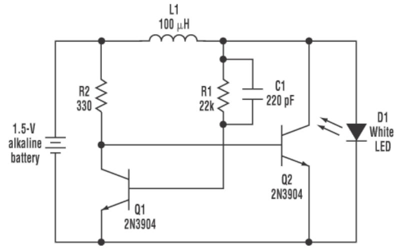
Click the picture to enlarge.



The voltage output is about 3Vpeak oscillating at about 33kHz.

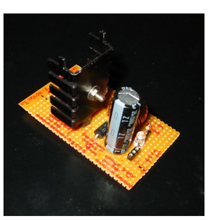
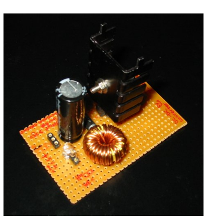


Schematic



LM2576 dc-dc Circuits

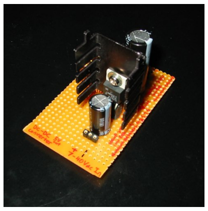
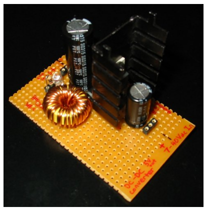
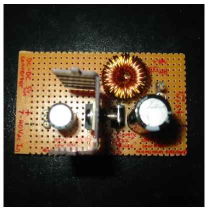
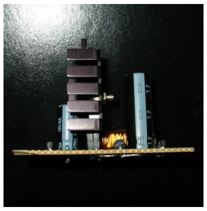
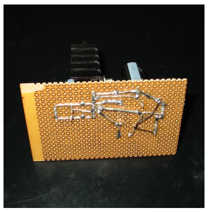
Photos of DC-DC circuit built

This is the 1st successful DC-DC circuit I built.

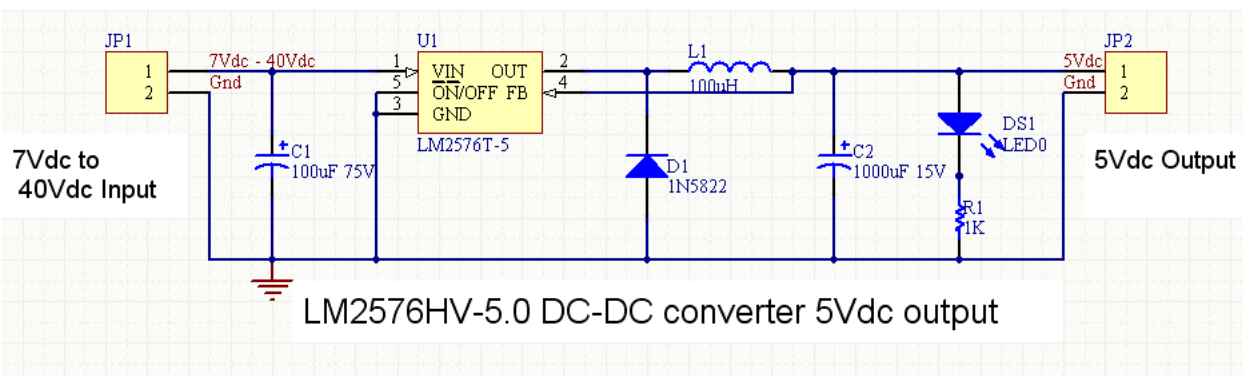
There a variety of capacitors out there in the market. Capacitance, voltage rating, dielectric material, etc... . Choose a suitable voltage rating across the capacitor. The circuits deals with high current, therefore it will be better to choose a low ESR (equivalent series resistance) Aluminum electrolytic capacitor. As a general guide, a higher voltage rating has lower ESR rating.

The inductor coil use should be able to handle the current passing through the inductor coil. If the wire is too thin, the coil may be burn or just fail. My previous circuit uses small wattage inductor (package like a big resistor). The circuit couldn't work and was later found to be IC problem. I have not yet do a test to check on the possibility of the inductor contributing to the failure.

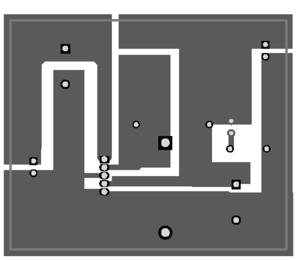






Using a inductor meter to measure the inductance will be easier. Inductance value can be observe immediately for any modification to the coil of wire. The inductance value can also be calculated, depend on the coil size, number of turns, wire size used, dielectric of the core etc... .

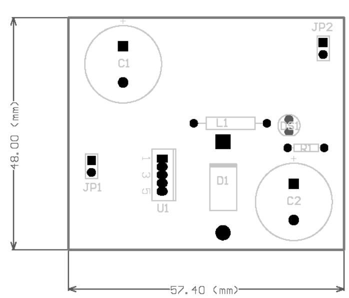
The 1N5822 is a high current, high speed, schottky diode and is suitable for this digital switching circuit. Schottky diode (Schottky Barrier Rectifier), means that the forward voltage drop is low. For this application, a low forward voltage diode is necessary.



Schematics



PCB Bottom Layer (PCB trace)



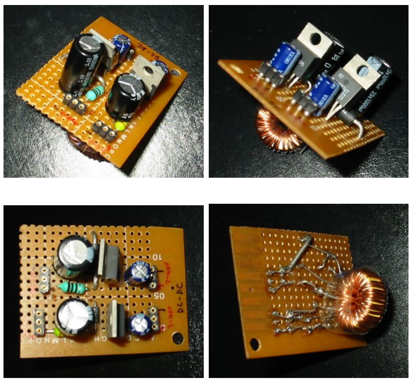
Component Layout (Silkscreen)

Bill of Material (BOM) for LM2576 circuit

Part#	Description	Value	Qty
C1	Electrolytic Capacitor (Axial)	100uF 75V	x1

C2	Aluminum Electrolytic Capacitors (Axial)	1000uF 16V	x1
~~D1~~	Schottky Diode (high current)	~~1N5822~~	~~x1~~
L1	Inductor	100uH	x1
U1	7-40V to 5V DC-DC 3.0A	LM2576T5	x1
R1	Resistor	1K	x1
DS1	Typical INFRARED GaAs LED		x1
JP1	Header, 2-Pin		x1
JP2	Header, 2-Pin		x1
PCB	PCB board 60x50mm	1 oz	x1

LM2576 circuits that failed



Failure, my first prototype circuit to test out the performance of LM2575, LM2576.

Initially I thought that I had use the wrong type of inductor, resulting in the circuit malfunction. Initially I had used a smaller type of inductor (looks like a resistor). Realizing that this circuit drive high current load, I should use a thicker inductor coil. That's why I modified the circuit with an inductor (enamelled wire, wound around the ferrite core).

Still it doesn't work. I guess that both IC LM2575, LM2576 must have been damage by my previous attempt. The capacitor used is suspected because the datasheet call for low ESR capacitor. It is very difficult to find these in the local shops, therefore I use a normal capacitor instead.

One day, I visited a shop selling ready made inductors and brought LM2576 at the same time. The circuit was rebuild and it finally works. My deduction at that time was either the inductor or the capacitor is giving me the problem. After further testing, I find out that ordinary capacitor works as well. There is hardly any difference in performance. Various type of inductor were tested (except the resistor like type). All inductor works too, big or small. Quite weird actually, and I couldn't figure it out the actual problem I had in my previous attempt.

Some of the various sizes of inductor tested and seems to be working with LM2576.

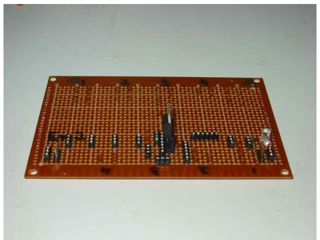
The mystery is resolve finally. One fine day I went back to the shop where I first purchase my LM2576 and brought 2 additional LM2576 for more testing. A new circuit was build and the familiar failure was observed. The output voltage of 5V cannot be sustain and eventually drop when more than 1A of current is draw by the load. The lab power supply display a current loading limit warning. IC becomes very hot. The datasheet specify that LM2576 should be able to supply 3A without any problem. Both brand new IC are tested to have the same problem.

This is weird, as the same inductor and capacitor previously tested do not result in this same old problem. However the circuit shows the same failure symptom. The next thing that comes to mind, is the IC. The IC LM2576 from the previous working circuit is then transfer over the new circuit board for testing. Everything works fine. It is then clear that the problem comes from the IC itself.

Checking up on the previous IC, I notice that they are from the same manufacturing batch number and believe that they are already damage in some way.

Sample of the 5Ω 50W aluminum house resistor used for testing 1A current performance.

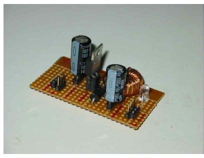
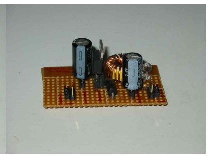
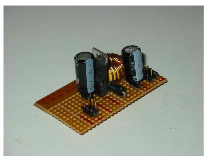
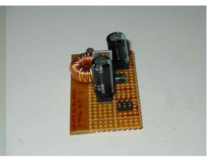
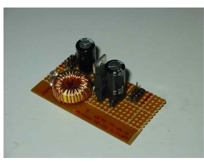
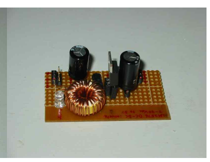
Using various type of inductor and capacitor. The circuit is tested to draw 1A using a 5Ω 50W resistor as the load. Current drawn can be observe on my lab power supply current meter. It should shows 1A being drawn, since the LM2576 supply a constant 5V to the 5Ω load.



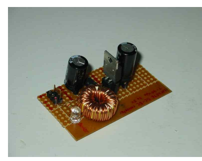
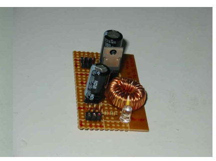
General tester for LM series dc-dc IC chip.

A multi purpose board is created to allow me to test various LM series IC chip. e.g. LM2575, LM2576, LM2596, LM2678, LM2679. Various combination of inductor, capacitor and diode can also be tested under this board.

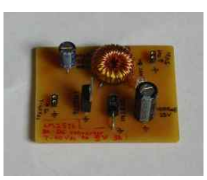
More LM2576 Circuits built

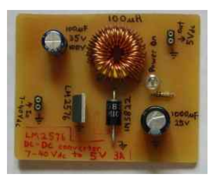
Some of the newly fabricated board built to support other prototype projects. It has been tested to support a RF transceiver operating at 5V without any issue observed.







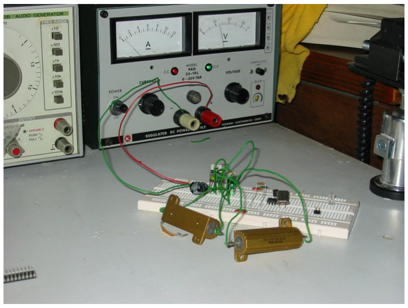
This is the same dc-dc circuit shown above. The circuit is fabricated from photo-resist PCB board. For more information on making your own PCB board, you may like to visit, website "..\2005-09-07_home_pcb_fabrication".



Home fabricated circuit board

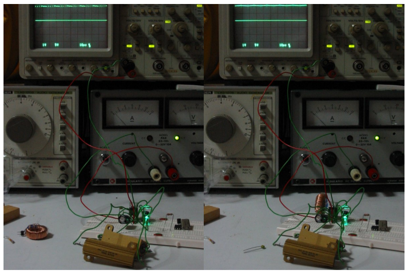
Working on LM2575

It has been some time since I learn to use LM2576. The circuitry is able to handle a higher current at 3A 5V output. This translate to a higher cost and circuit size, since all component must be able to handle that high power capacity. These component include the LM2576, inductor and the diode. Since most electronics kit requires less than 1A power supply, it is wise learning



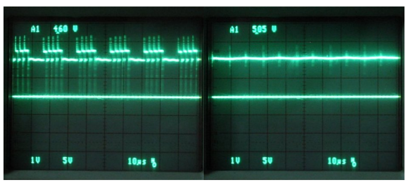
how to apply a low power dc-dc regulator like LM2575. Cost can be reduce by 50%.

There is one day that I happen to come across this IC LM2575 while searching high and low for LM2576. LM2576 is actually quite difficult to find. There is only 2 shop I know of, but I have rule out one shop because they are selling a faulty batch of LM2576 IC. LM2575 seems very common from shops around and I decided to find out more about this chip. Indeed it is what I have been looking for, a low power regulator. So I purchase the IC and its component to try it out. When I started writing this acticle, only did I realize that I have actually tried it about 6 months ago. The experiment was forgotten after a series of failure.



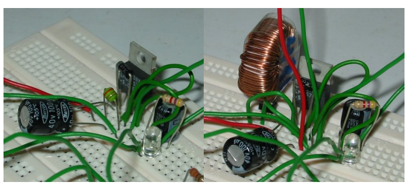
But now, it is working once more. The experience in working with LM2576 has provided the confident to built LM2575. It is so fortunate that I managed to get this circuit working once again.

The following experiment is done during the 1st test on LM2575 circuit. The experiment compare between the performance of using different inductor. One using a wire coil inductor, and the other smaller one inductor that looks like a resistor with it's color bands..



The photos on the left column shows the LM2575 circuit using the correct inductance value at 330uH but the inductor is low power rated. It is small and looks like a color coded resistor.

A few second after the left circuit is powered up, the small inductor turns very hot. The waveform observed at the output of the dc-dc regulator, contains a high amount of noise/ripple energy.



The photo on the right column shows the same circuit using a slightly higher inductance at 480uH but the coil is thicker and bigger in size.

The circuit using a high power rating inductor on the right shows a cleaner DC supply, although the inductance value is different from the design. There is still ripple at it's output but I guess it will be minimum using an inductance value of 330uH with higher power rating. Too bad, I do not have the right inductor to experiment further. It is either coil one myself or buy one from shop.

12 June 2006, Lim Siong Boon

I have found this article regarding about the property of inductor Isat (current saturation) and Irms (continuous current). They are usually one of the important specification to take note while selecting inductor from datasheet.

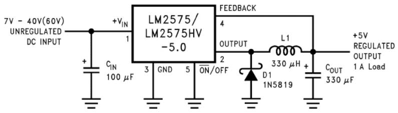
Current saturation means the amount of current required that flow through the inductor, in order to reduce the inductance of the component.

Continuous current means the amount of current required to heat up the inductor to a certain temperature. If the amount current continue to flow through the inductor, the inductor is basically becoming a heater. The temperature depends on the amount of current flowing through it.

The following contains information that I learn from.

Isat_Irms explain.pdf

02 Dec 2008, Lim Siong Boon



LM2575 Schematic taken from National Semiconductor
[LM2575 datasheet]

Bill of Material (BOM) for LM2575 circuit

Part#	Description	Value	Qty
C1	Electrolytic Capacitor (Axial)	100uF 75V	x1
C2	Aluminum Electrolytic Capacitors (Axial)	330uF 16V	x1
D1	Schottky Diode (low current)	1N5819	x1
L1	Inductor	330uH	x1
U1	7-40V to 5V DC-DC 1.0A	LM2575T5	x1
R1	Resistor	1K	x1
DS1	Typical INFRARED GaAs LED		x1
JP1	Header, 2-Pin		x1
JP2	Header, 2-Pin		x1
PCB	PCB board 60x50mm	1 oz	x1

Dealing with power supply noise

I happen to see this very good website, teaching about handling noise. There are many illustration which are easy to understand.

http://www.williamson-labs.com/480_byp.htm

04 Oct 2011, Lim Siong Boon

Quick Design Guide to

Switching Power IC

LM2575, LM2576, LM2596, LM2678

The following table provides a quick reference for power supply circuit. The circuit schematic and compo manufacturer's datasheet.

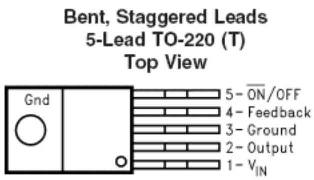
For exact component value design, you need to the datasheet. The following component value is desig 12Vdc or 24Vdc drawing power at 75% of the current rating.

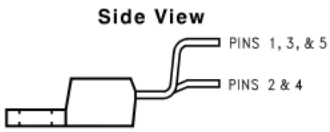
LM2575 (1A)
DC to DC step down voltage regulator.
Wide input voltage 8Vdc to 40Vdc.

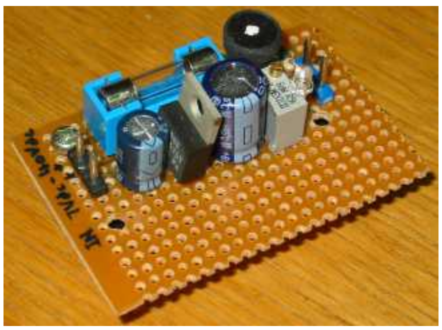
Part number:
- LM2575-3.3 (3.3Vdc output)
- LM2575-5.0 (5Vdc output)
- LM2575-12 (12Vdc output)
- LM2575-15 (15Vdc output)
- LM2575-ADJ (1.23Vdc to 37Vdc output)

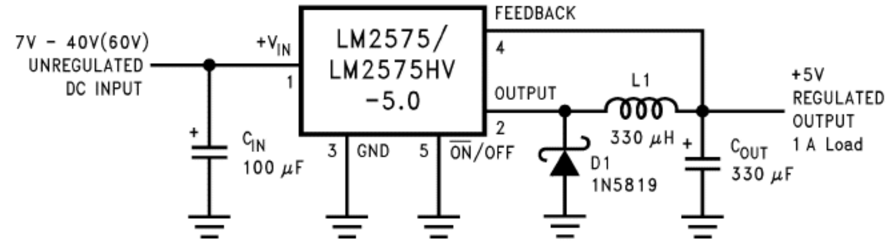
Alternative:
NJM2367

Package: TO-220(T)









LM2575 datasheet

Click for LM2575-adj circuit

Component list

Symbol	Component
C1	100uF (50V aluminium electrolytic)
C2	330uF (16V aluminium electrolytic, low ESR)
D1	1N5819 (schottky diode 1A)
L1	330uH, 1A <for LM2575-3.3, LM2575-5.0> 680uH, 1A <for LM2575-12, LM2575-15>
R1, R2	"for LM2575-adj IC" 5kΩ multi-turn variable resistor, set to ratio to R1=1.25k voltage output of 5Vdc before soldering.

For 3.3V output	
R1	**R2**
1.00kΩ	1.68kΩ
3.30kΩ	5.55kΩ
4.70kΩ	7.91kΩ
1.96kΩ	**3.30kΩ**
2.79kΩ	**4.70kΩ**
3.33kΩ	**5.60kΩ**

Commercial Resistor value		Actual Output
R1	**R2**	**Vout**
1.0kΩ		
3.3kΩ (3.24kΩ)	**5.6kΩ** (5.49kΩ)	3.32V
4.7kΩ		
	3.3kΩ	
	4.7kΩ	
3.3kΩ (3.24kΩ)	**5.6kΩ** (5.49kΩ)	3.32V

For 5.0V output	
R1	**R2**
1.00kΩ	3.07kΩ
3.30kΩ	10.10kΩ
4.70kΩ	14.40kΩ
1.08kΩ	**3.30kΩ**
1.53kΩ	**4.70kΩ**
1.83kΩ	**5.60kΩ**
3.26kΩ	**10.00kΩ**

Commercial Resistor value		Actual Output
R1	**R2**	**Vout**
1.0kΩ		
3.3kΩ (3.24kΩ)	**10.0kΩ** (10.00kΩ)	4.96V
4.7kΩ		
	3.3kΩ	
	4.7kΩ	
	5.6kΩ	
3.3kΩ (3.24kΩ)	**10.0kΩ** (10.00kΩ)	4.96V

please refer to the table for resistors in parallel for more resistance design options.

Other voltage output base on commercial available resistors	

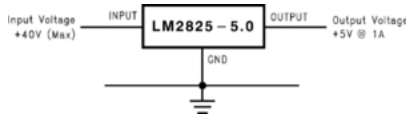
Commercial Resistor value		Actual Output
R1	**R2**	**Vout**
1.0kΩ	**4.7kΩ**	7.011V
1.18kΩ	**18kΩ**	19.9927V

Vout, R1 & R2 design selection calculator

Vout=   , R1=   , R2=   where R1 between 1kΩ to 5kΩ.

Design calculator might not work on some web browser.

LM2825 (1A)
DC to DC step down voltage regulator.
Wide input voltage up to 40Vdc.

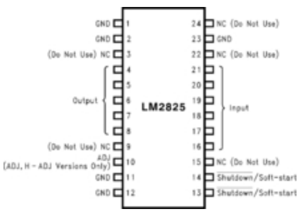


Part number:
- LM2825-3.3 (3.3Vdc output)
- LM2825-5.0 (5Vdc output)
- LM2825-12 (12Vdc output)
- LM2825-ADJ (1.23Vdc to 37Vdc output)

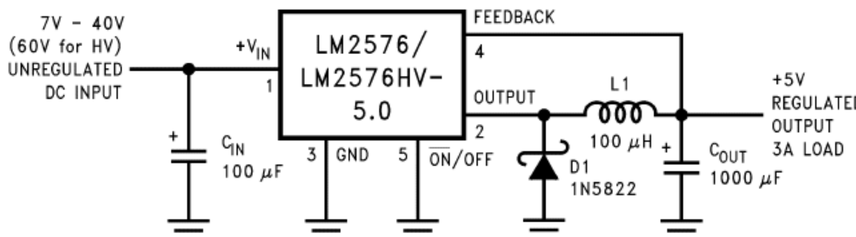
[LM2825 datasheet]

no external component required

Package: MDIP24



LM2576 (3A)
DC to DC step down voltage regulator.
Wide input voltage 8Vdc to 40Vdc.



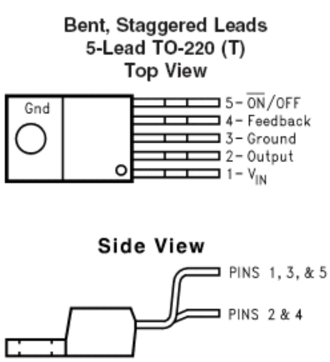
Part number:
- LM2576-3.3 (3.3Vdc output)
- LM2576-5.0 (5Vdc output)
- LM2576-12 (12Vdc output)
- LM2576-15 (15Vdc output)
- LM2576-ADJ (1.23Vdc to 37Vdc output)

[LM2576 datasheet]

Alternative:
[NJM2367]

Package: TO-220(T)

[Click for LM2576-5.0 layout]

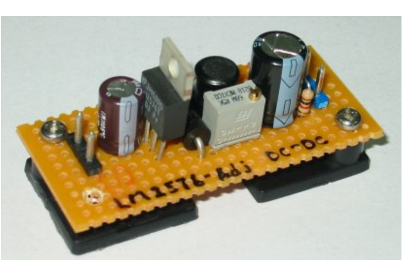


[Click for LM2576-adj circuit]

[Click for LM2576-adj layout]

Reference:

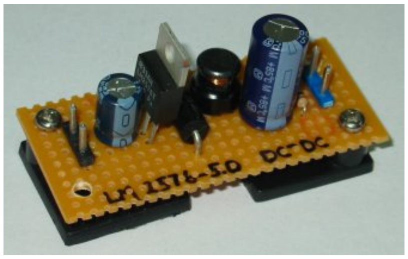
- [AN-946, lm2576 as a charger]



Component list

Symbol	Component
C1	100uF (50V aluminium electrolytic)
C2	1000uF (16V aluminium electrolytic, low ESR)
D1	1N5822 (schottky diode 3A)

tested working on 2007-06-26



tested working on 2007-06-26

L1	100uH, 3A <for LM2576-3.3, LM2576-5.0> 220uH, 3A <for LM2576-12, LM2576-15>
R1, R2	"for LM2576-adj IC" 5kΩ multi-turn variable resistor, set to ratio to R1=1.25k voltage output of 5Vdc before soldering.

Resistor value for Adj (adjustable version). Voltage reference is 1.23V

For 3.3V output	
R1	R2
1.00kΩ	1.68kΩ
3.30kΩ	5.55kΩ
4.70kΩ	7.91kΩ
1.96kΩ	**3.30kΩ**
2.79kΩ	**4.70kΩ**
3.33kΩ	**5.60kΩ**
1.1kΩ	1.851kΩ
1.2kΩ	2.020kΩ
1.3kΩ	2.187kΩ
1.5kΩ	2.524kΩ

Commercial Resistor value		Actual Output
R1	R2	Vout
1.0kΩ		
3.3kΩ (3.24kΩ)	**5.6kΩ** (5.49kΩ)	3.32V
4.7kΩ		
	3.3kΩ	
	4.7kΩ	
3.3kΩ (3.24kΩ)	**5.6kΩ** (5.49kΩ)	3.32V
1.1kΩ	**1.87kΩ**	3.32V
1.2kΩ	**2.05kΩ**	3.33V
1.3kΩ	**2.20kΩ**	3.31V
1.5kΩ	**2.55kΩ**	3.32V

For 5.0V output	
R1	R2
1.00kΩ	3.07kΩ
3.30kΩ	10.10kΩ
4.70kΩ	14.40kΩ
1.08kΩ	**3.30kΩ**
1.53kΩ	**4.70kΩ**
1.83kΩ	**5.60kΩ**
3.26kΩ	**10.00kΩ**

Commercial Resistor value		Actual Output
R1	R2	Vout
1.0kΩ		
3.3kΩ (3.24kΩ)	**10.0kΩ** (10.00kΩ)	4.96V
4.7kΩ		
	3.3kΩ	
	4.7kΩ	
	5.6kΩ	
3.3kΩ (3.24kΩ)	**10.0kΩ** (10.00kΩ)	4.96V

please refer to the table for resistors in parallel for more resistance design options.
please refer to above for design calculator for resistance value selective

LM2594 (0.5A)
DC to DC step down voltage regulator.
Wide input voltage 8Vdc to 37Vdc (up to 60V for HV version).

Part number:
- LM2594-3.3 (3.3Vdc output)
- LM2594-5.0 (5Vdc output)
- LM2594-12 (12Vdc output)
- LM2594-ADJ (1.23Vdc to 37Vdc output) (57V for HV version)

Package: SOIC8, DIP8

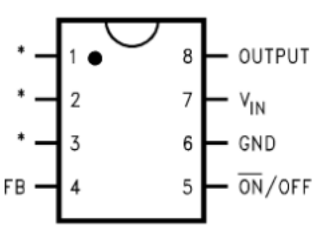
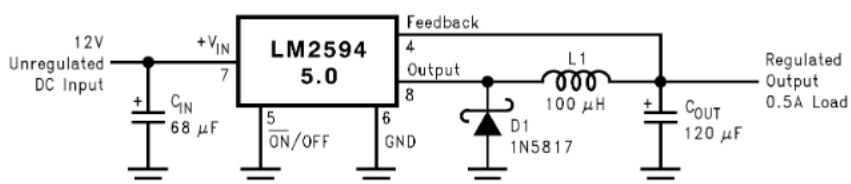


Figure 1. 8-Pin - Top View
See Package Number P0008E



LM2594 datasheet

Component list

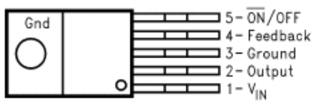
Symbol	Component
C1	68uF (50V aluminium electrolytic)
C2	120uF (16V aluminium electrolytic, low ESR)
D1	1N5817 (schottky diode 1A)
L1	100uH, 0.5A

LM2596 (3A)
DC to DC step down voltage regulator.
Wide input voltage 8Vdc to 40Vdc.

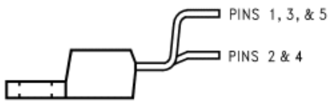
Part number:
- LM2596-3.3 (3.3Vdc output)
- LM2596-5.0 (5Vdc output)
- LM2596-12 (12Vdc output)
- LM2596-ADJ (1.23Vdc to 37Vdc output)

Package: TO-220 (T)

Bent, Staggered Leads
5-Lead TO-220 (T)
Top View



Side View



[LM2596 datasheet]

Component list

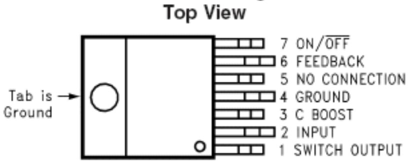
Symbol	Component
C1	680uF (50V aluminium electrolytic)
C2	330uF (100V aluminium electrolytic, low ESR) <for LM2596-3.3, LM2596-5. 180uF (100V aluminium electrolytic, low ESR)<for LM2596-12>
D1	1N5824 (schottky diode 4A)
L1	33uH, 3A <for LM2596-3.3, LM2596-5.0> 68uH, 3A <for LM2596-12>

LM2678 (5A)
DC to DC step down voltage regulator.
Wide input voltage 8Vdc to 40Vdc.

Part number:
- LM2678-3.3 (3.3Vdc output)
- LM2678-5.0 (5Vdc output)
- LM2678-12 (12Vdc output)
- LM2678-ADJ (1.2Vdc to 37Vdc output)

Package: TO-220

TO-220 Package
Top View



[LM2678 datasheet]

Component list

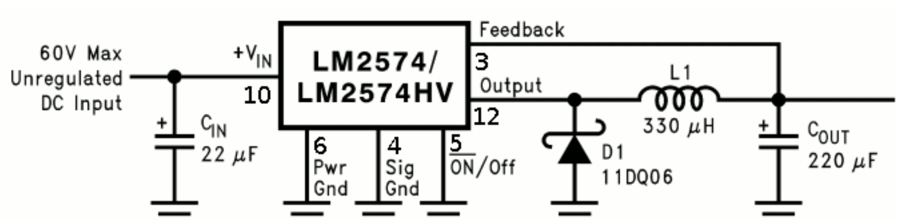
Symbol	Component
C1	45uF (50V aluminium electrolytic) + 0.47uF
C2	10nF (50V ceramic, low ESR)
C3	360uF (100V aluminium electrolytic, low ESR) <for LM2678-3.3, LM2678-5. 220uF (100V aluminium electrolytic, low ESR)<for LM2678-12>
D1	6TQ045S (schottky diode 6A)
L1	15uH, 5A <for LM2678-3.3, LM2678-5.0> 22uH, 5A <for LM2678-12>

LM2574 (0.5A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

Part number:
- LM2574-5.0 (5Vdc output)
- LM2574-ADJ (1.2Vdc to Vin output)

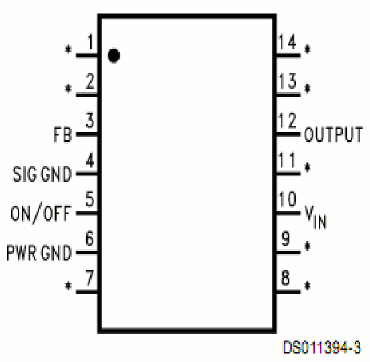
Alternative:
NJM2369A, NJM2374A

Package: Wide-SOIC14



[LM2574 datasheet]

Click for LM2574-adj circuit



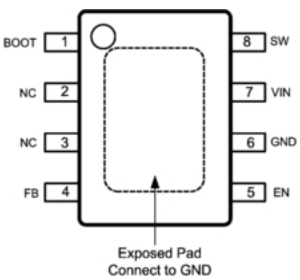
Component list

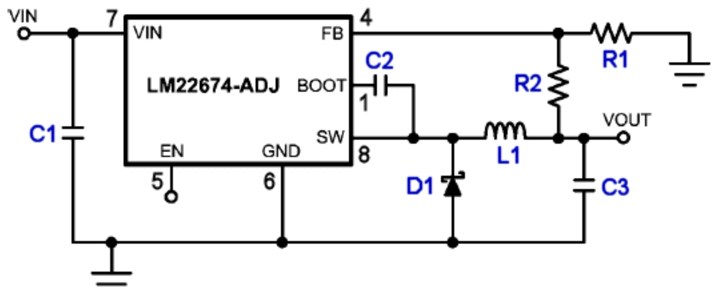
Please see the section for LM2574, LM2576. They are similar.

LM22674 (0.5A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

Part number:
- LM22674-5.0 (5Vdc output)
- LM22674-ADJ (1.2Vdc to Vin output)

Package: PSOP8





[LM22674 datasheet]

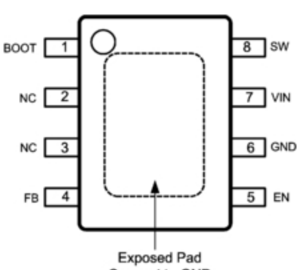
Component list

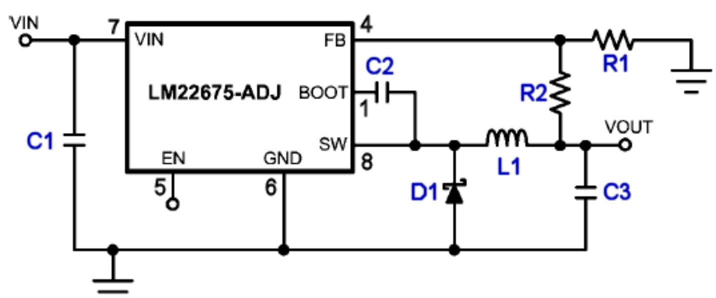
Symbol	Component
C1	22uF (50V aluminium electrolytic) + 1uF (50V ceramic, low ESR)
C2	10nF (50V ceramic, low ESR)
C3	22uF (50V aluminium electrolytic) + 1uF (50V ceramic, low ESR)
D1	1N5819 (schottky diode 1A)
L1	39uH (>0.5A)
R1, R2	<For 3.3Vout> R1=976Ω, R2=1.54kΩ (1/8watt) for Vout R1 R2 computation reference, refer to LM22676 section

LM22675 (1A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

Part number:
- LM22675-5.0 (5Vdc output)
- LM22675-ADJ (1.285Vdc to Vin output)

Package: PSOP8

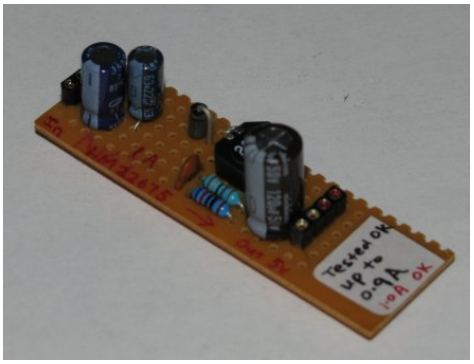


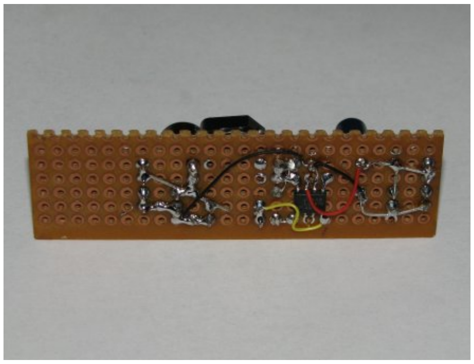


[LM22675 datasheet]

Component list

Symbol	Component
C1	22uF (50V aluminium electrolytic) + 1uF (50V ceramic, low ESR)
C2	10nF (50V ceramic, low ESR)
C3	120uF (16V aluminium electrolytic) + 1uF (50V ceramic, low ESR)
D1	1N5822 (schottky diode 2 to 3A)
L1	22uH (>1A)
R1, R2	<For 3.3Vout> R1=976Ω, R2=1.54kΩ (1/8watt)



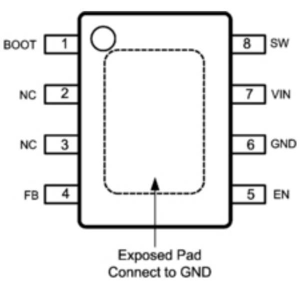


for Vout R1 R2 computation reference, refer to LM22676 section

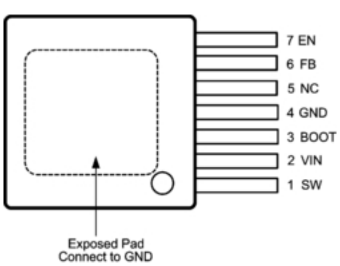
LM22676 (3A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

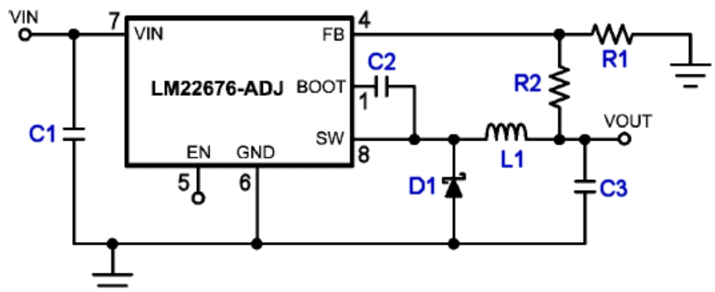
Part number:
- LM22676-5.0 (5Vdc output)
- LM22676-ADJ (1.285Vdc to Vin output)

Package: PSOP8



TO-263 thin (7 pin)





LM22676 datasheet

Component list

Symbol	Component
C1	22uF (50V aluminium electrolytic) + 2.2uF (50V ceramic, low ESR)
C2	10nF (50V ceramic, low ESR)
C3	120uF (50V aluminium electrolytic) + 2.2uF (50V ceramic, low ESR)
D1	50WQ03 (schottky diode 5.5A)
L1	8.2uH (>5.5A)
R1, R2	<For 3.3Vout> R1=976Ω, R2=1.54kΩ (1/8watt) <For 5.0Vout> R1=1kΩ, R2=2.89kΩ

The following guide uses typical resistor value.
<For 3.21Vout> R1=1kΩ, R2=1.5kΩ
<For 3.26Vout> R1=1kΩ, R2=1.54kΩ
<For 3.31Vout> R1=976Ω, R2=1.54kΩ
<For 3.34Vout> R1=1kΩ, R2=1.6kΩ
<For 3.39Vout> R1=1.1kΩ, R2=1.8kΩ
<For 3.41Vout> R1=2kΩ, R2=3.3kΩ
<For 3.47Vout> R1=3.3kΩ, R2=5.6kΩ
<For 5.06Vout> R1=1.6kΩ, R2=4.7kΩ
<For 5.14Vout> R1=1kΩ, R2=3kΩ
<For 5.14Vout> R1=1.1kΩ, R2=3.3kΩ
<For 5.16Vout> R1=1.54kΩ, R2=4.64kΩ
<For 5.21Vout> R1=1.54kΩ, R2=4.7kΩ
<For 5.23Vout> R1=976Ω, R2=3kΩ

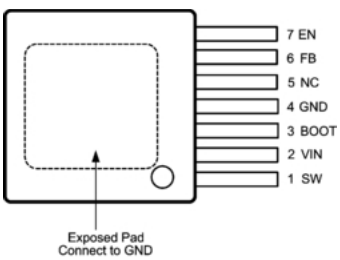
Formula for LM22676-ADJ version (for Vout < 5V)
$R1=(R2/((V_{out}/V_{FB})-1))$
$R2=R1((V_{out}/V_{FB})-1)$

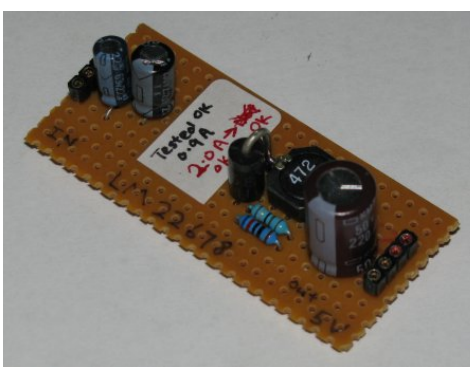
$V_{out}=V_{FB}((R2/R1)+1)$, where $V_{FB}=1.285V$,
R1+R2 is about 3kΩ & must be <10kΩ

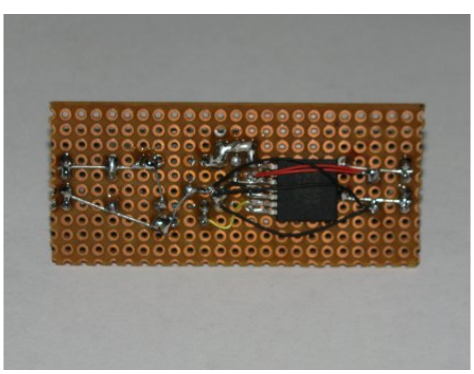
LM22678 (5A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

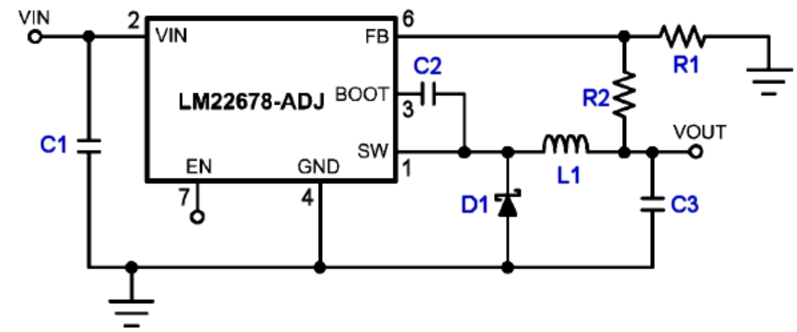
Part number:
- LM22678-5.0 (5Vdc output)
- LM22678-ADJ (1.285Vdc to Vin output)

Package: TO-263 thin (7 pins)









LM22678 datasheet

Component list

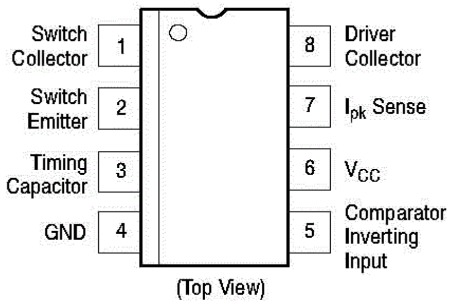
Symbol	Component
C1	22uF (50V aluminium electrolytic) + 2.2uF (50V ceramic, low ESR)
C2	10nF (50V ceramic, low ESR)
C3	180uF (16V aluminium electrolytic) + 2.2uF (50V ceramic, low ESR)
D1	50WQ03 (schottky diode 5.5A)
L1	4.7uH (8.5A)
R1, R2	<For 3.3Vout> R1=976Ω, R2=1.54kΩ (1/8watt) for Vout R1 R2 computation reference, refer to LM22676 section

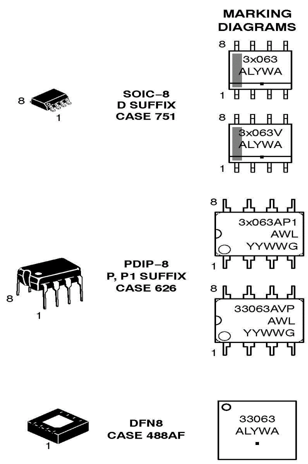
MC34063 (1.5A)
DC to DC step down/up.invert voltage regulator.
Wide input voltage 3.0Vdc to 40Vdc.

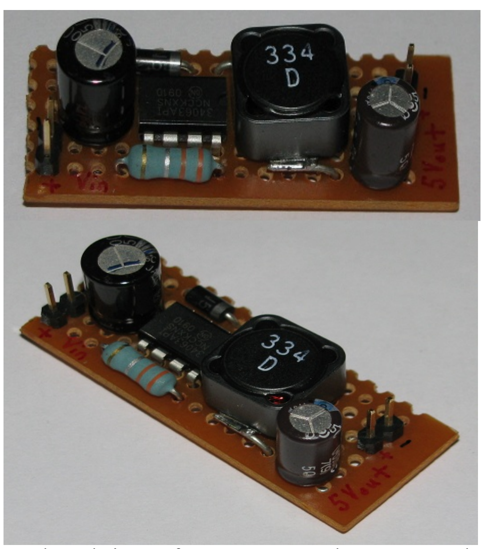
Circuit 1: Step down dc-dc 25Vin -> 5Vout (0.5A)

Part number:
- MC34063A, MC33063A
- SC34063A, SC33063A
- NCV33063A

Package: SOIC-8, PDIP-8, DFN8 (8 pins)



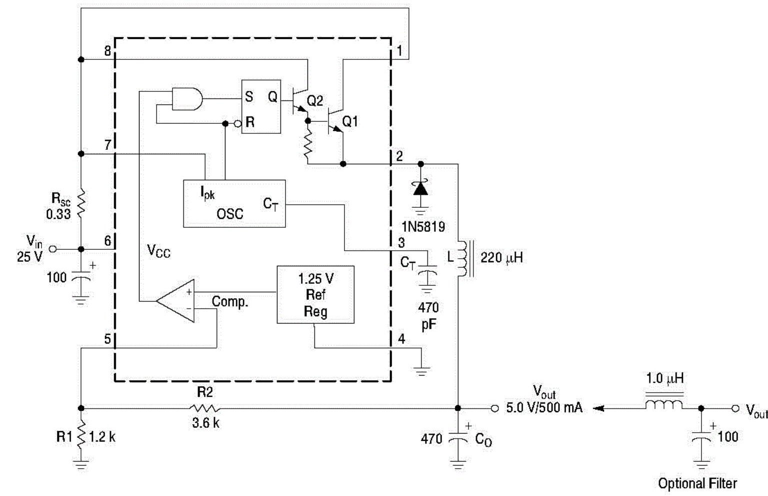




Load regulation performance measured seems poor. Ideally, this is a 5V 0.5A voltage regulator.
1) Vin=10V, Vout=4.92Vdc, Load=opened circuit (0A)
R2=10kΩ, R1=3.3kΩ, Rsc=0.33Ω 0.5W, L=330uH
2) Vin=10V, Vout=4.10Vdc, Load=15Ω (0.27A)
3) Vin=10V, Vout=3.00Vdc, Load=10Ω (0.3A)

Seems that the circuit can only handle 0.1-0.2A load. The voltage regulation is quite poor. According to the document, it is ok for the inductance to be higher. Could it be that my R1 & R2 value being too high? I need to check it up.

MC34063A, MC33063A, SC34063A, SC33063A, NCV33063A



Current rating can be boost by using external transistor to drive the load.

Adjustable Vout computation (very similar to LM2576, LM2575) with Vref = 1.25V

Vout = 1.25 [1+(R2/R1)]

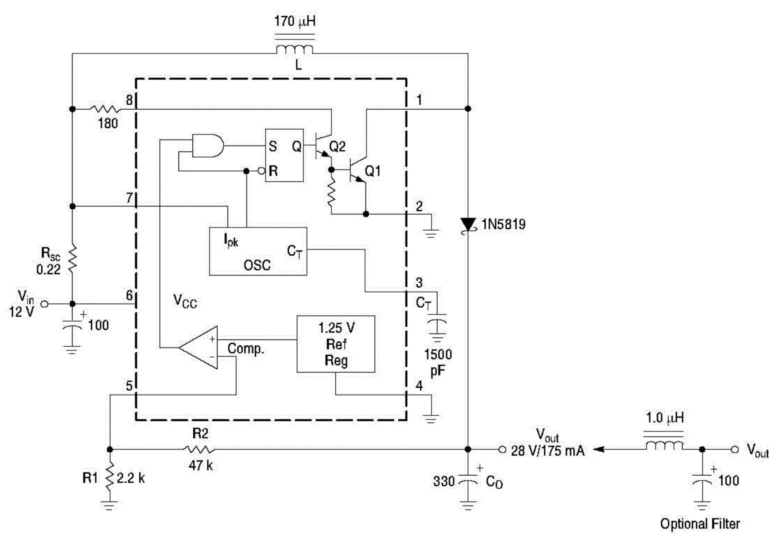
R2 = R1 [(Vout/1.25)-1)]

<For 3.3Vout> R1=3.3kΩ, R2=5.6kΩ
<For 5.0Vout> R1=3.3kΩ, R2=10kΩ

<For 0.5A Iout> Rsc = 0.3 / (2*Iout) = 0.3 / (2*0.5A) = **0.3Ω** (0.075W), please note that Iout < 1.5A usi

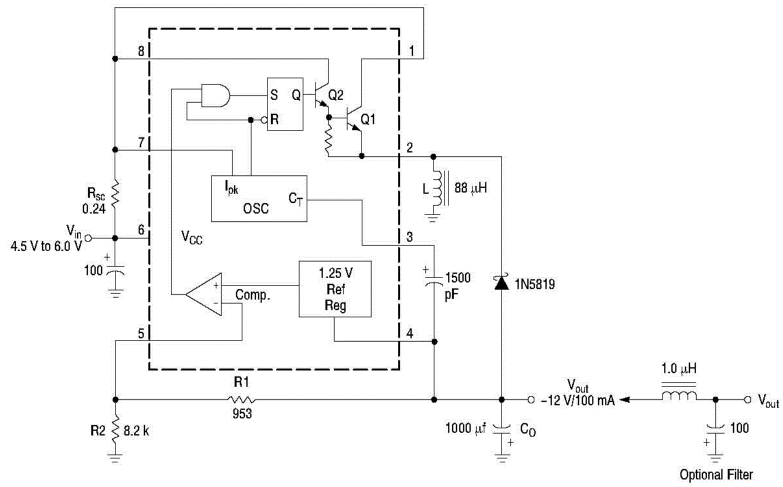
Circuit 2: Step up dc-dc 12Vin -> 28Vout (0.175A)

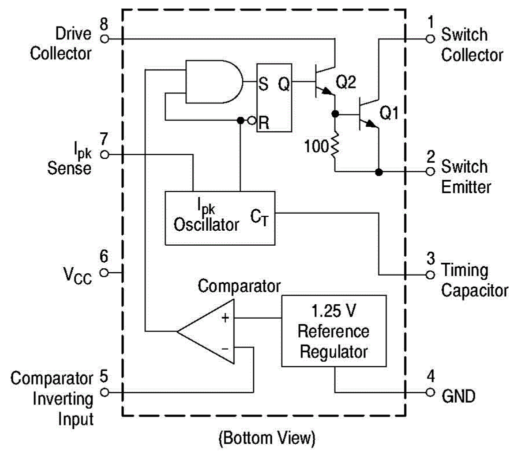
MC34063A, MC33063A, SC34063A, SC33063A, NCV33063A



Circuit 3: Step up inverting dc-dc 4.5-6Vin -> -12Vout (0.1A)

MC34063A, MC33063A, SC34063A, SC33063A, NCV33063A





[MC34063A-D datasheet](#)

[MC34063 project example.pdf](#)

[MC34063 AN10360, Schottky rectifiers for DCDC converters.pdf](#)

[MC34063 AN920-D, Theory and Applications.pdf](#)

[MC34063 slva252b, Application Switching Regulator.pdf](#)

NCP3063 (1.5A)
DC to DC step down/up.invert voltage regulator.
Wide input voltage up to 40Vdc. Almost similar to MC34063 dc-dc ic.

Part number:
- NCP3063, NCP3063B, NCV3063

Package: SOIC-8, PDIP-8, DFN8 (8 pins)

NCP3063 is very similar to MC34063. Please refer to MC34063 for some handy information.

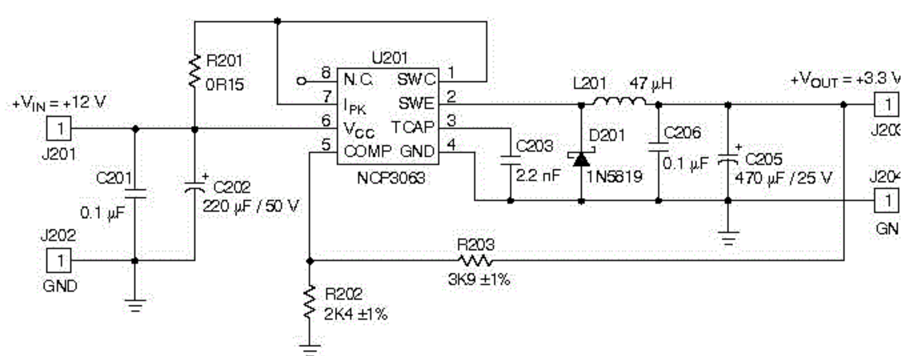


Figure 16. Typical Buck Application Schematic

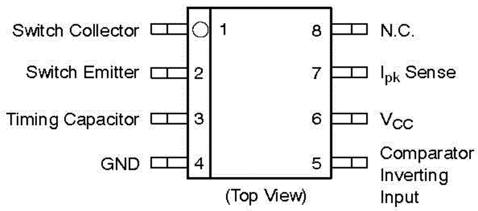
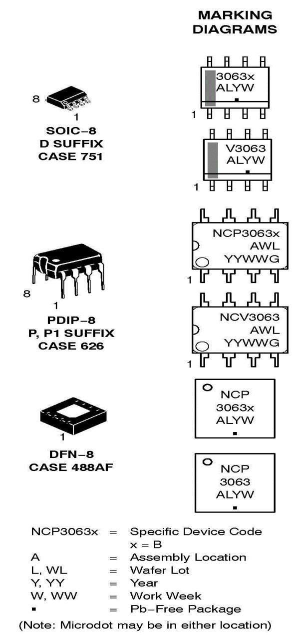


Figure 2. Pin Connections



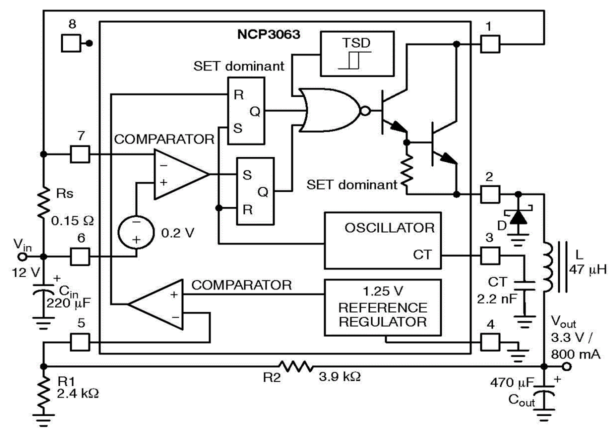


Figure 1. Typical Buck Application Circuit

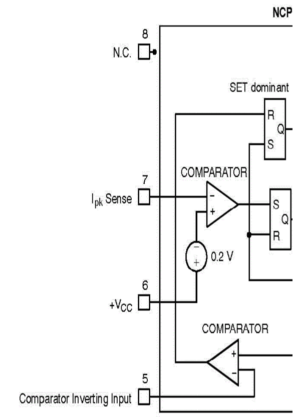


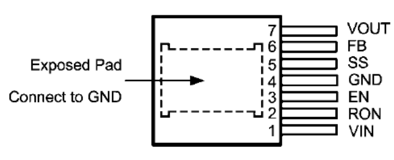
Figure 4. Bl

[NCP3063 datasheet]

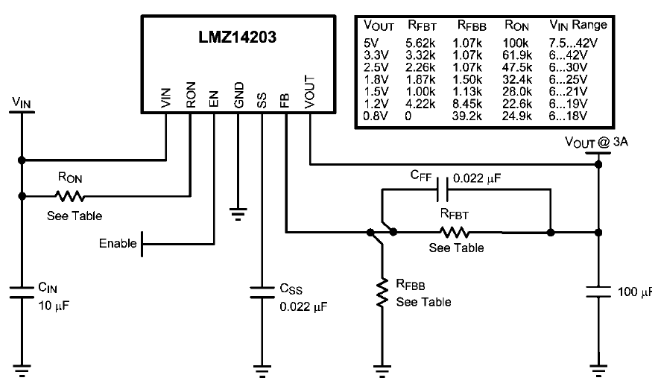
LMZ14203 (3A)
DC to DC step down voltage regulator.
Wide input voltage 6Vdc to 42Vdc.

Part number:
- LMZ14203TZ-ADJ (0.8Vdc to 6Vdc output)

Package: TO-PMOD (7 pins)



Top View
7-Lead TO-PMOD



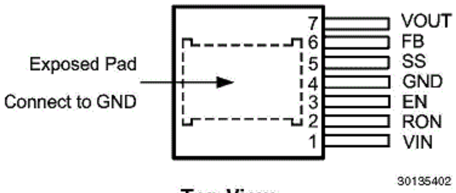
V_{OUT}	R_{FBT}	R_{FBB}	R_{ON}	V_{IN} Range
5V	5.62k	1.07k	100k	7.5...42V
3.3V	3.32k	1.07k	61.9k	6...42V
2.5V	2.26k	1.07k	47.5k	6...30V
1.8V	1.87k	1.50k	32.4k	6...25V
1.5V	1.00k	1.13k	28.0k	6...21V
1.2V	4.22k	8.45k	22.6k	6...19V
0.8V	0	39.2k	24.9k	6...18V

[LMZ14203 datasheet]

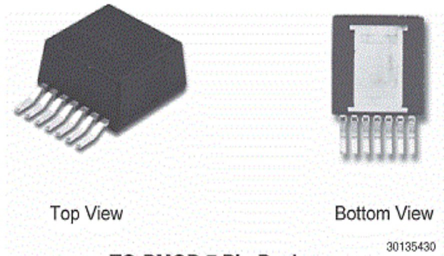
LMZ14201 (1A)
DC to DC step down voltage regulator.
Wide input voltage 6Vdc to 42Vdc.

Part number:
- LMZ14201H (5Vdc to 30Vdc output)

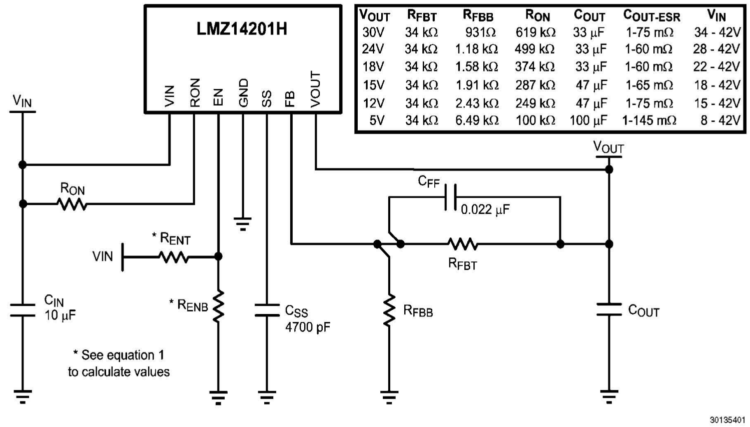
Package: TO-PMOD (7 pin)



Top View
7-Lead TO-PMOD



TO-PMOD 7 Pin Package



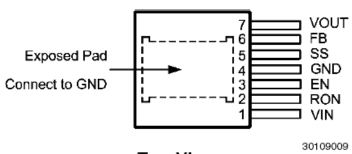
V_{OUT}	R_{FBT}	R_{FBB}	R_{ON}	C_{OUT}	$C_{OUT-ESR}$	V_{IN}
30V	34 kΩ	931Ω	619 kΩ	33 µF	1-75 mΩ	34 - 42V
24V	34 kΩ	1.18 kΩ	499 kΩ	33 µF	1-60 mΩ	28 - 42V
18V	34 kΩ	1.58 kΩ	374 kΩ	33 µF	1-60 mΩ	22 - 42V
15V	34 kΩ	1.91 kΩ	287 kΩ	47 µF	1-65 mΩ	18 - 42V
12V	34 kΩ	2.43 kΩ	249 kΩ	47 µF	1-75 mΩ	15 - 42V
5V	34 kΩ	6.49 kΩ	100 kΩ	100 µF	1-145 mΩ	8 - 42V

[LMZ14201H datasheet]

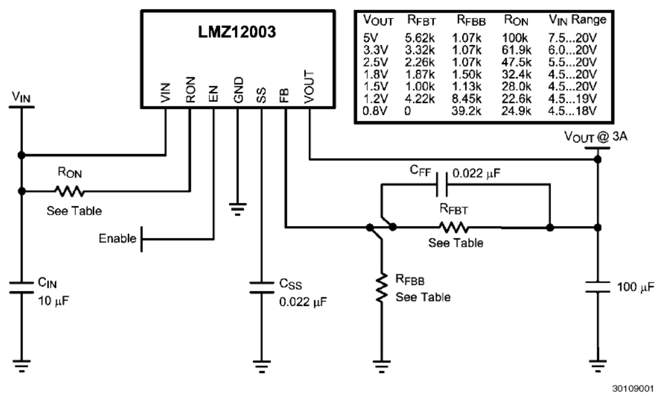
LMZ12003 (3A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 20Vdc.

Part number:
- LMZ12003TZ-ADJ (0.8Vdc to 6Vdc output)

Package: TO-PMOD (7 pin)



Top View
7-Lead TO-PMOD



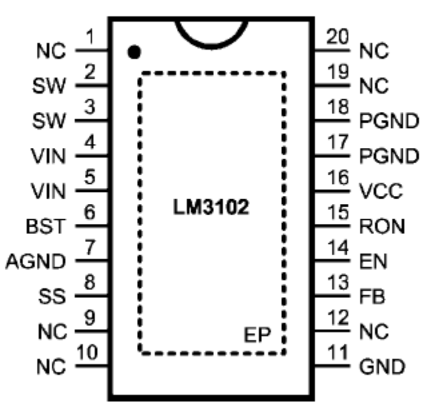
V_{OUT}	R_{FBT}	R_{FBB}	R_{ON}	V_{IN} Range
5V	5.62k	1.07k	100k	7.5...20V
3.3V	3.32k	1.07k	61.9k	6.0...20V
2.5V	2.26k	1.07k	47.5k	5.5...20V
1.8V	1.87k	1.50k	32.4k	4.5...20V
1.5V	1.00k	1.13k	28.0k	4.5...20V
1.2V	4.22k	8.45k	22.6k	4.5...19V
0.8V	0	39.2k	24.9k	4.5...18V

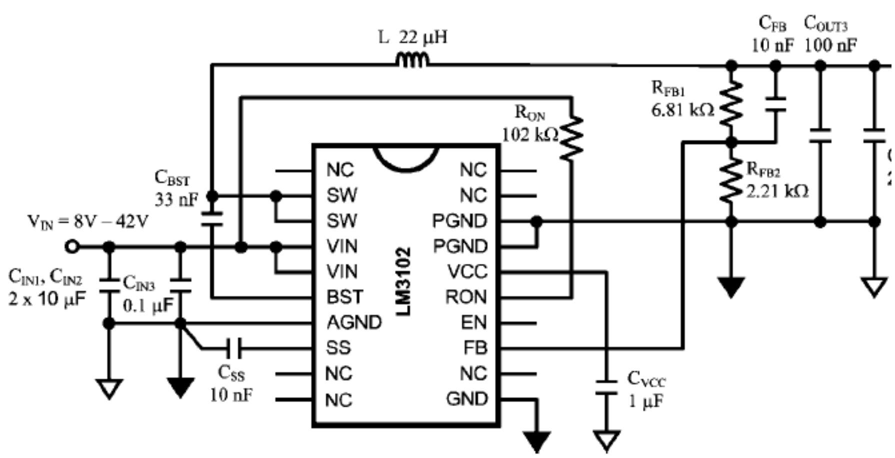
[LMZ12003 datasheet]

LM3102 (2.5A)
DC to DC step down voltage regulator.
Wide input voltage 4.5Vdc to 42Vdc.

Part number:
- LM3102MH

Package: TSSOP (20 pin)





Typical Application Schematic for V_{OUT} = 3.3V

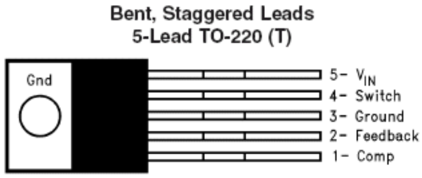
[LM3102 datasheet]

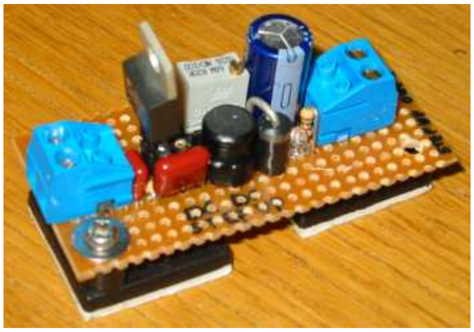
LM2577 (3A)

DC to DC step up voltage regulator.
Wide input voltage 3.5Vdc to 40Vdc.

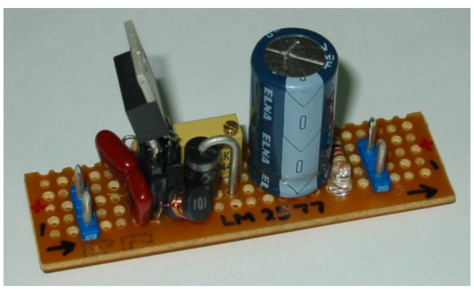
Part number:
- LM2577-12 (12Vdc output)
- LM2577-15 (15Vdc output)
- LM2577-ADJ (1.23Vdc to 37Vdc output)

Package: TO-220 (T)

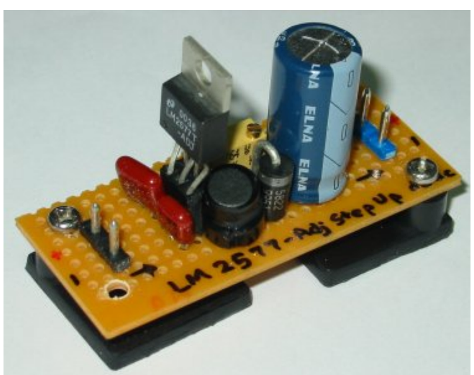




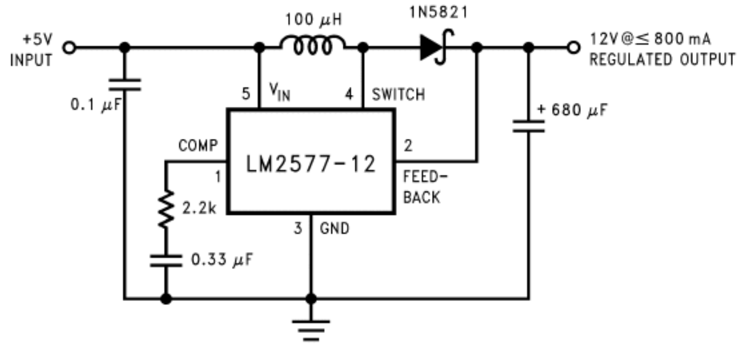
tested working on 2006



tested working on 2007-06-21



tested working on 2007-06-21



LM2577 datasheet

Click for LM2577-adj circuit

Click for LM2577-adj layout

Component list

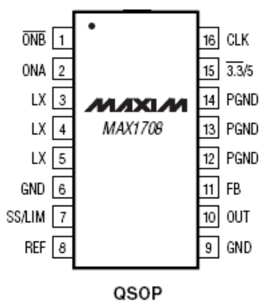
Symbol	Component
-	0.1uF
-	0.33uF
-	680uF (50V aluminium electrolytic)
-	1N5822 (schottky diode 3A)
-	100uH, 3A
-	2.2kΩ 1/4W resistor
-	"for LM2577-adj IC" 20kΩ multi-turn variable resistor, set to ratio to R2=2kΩ voltage output of 12Vdc before soldering.

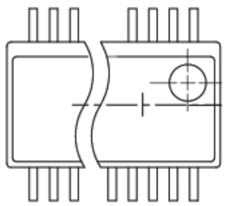
MAX1708 (2A, 10W)
DC to DC step up voltage regulator.
Low input voltage 0.7-5.0Vdc
to output voltage 2.5-5.5Vdc
Suitable for battery powered circuit.

Part number:

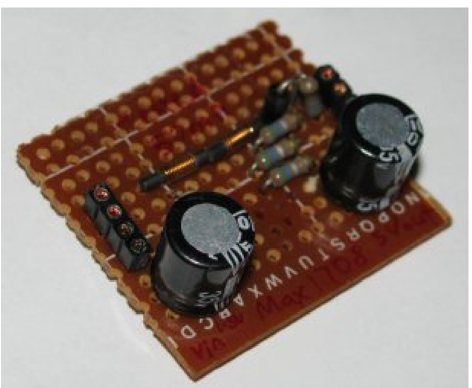
- MAX1708EEE

Package: QSOP16

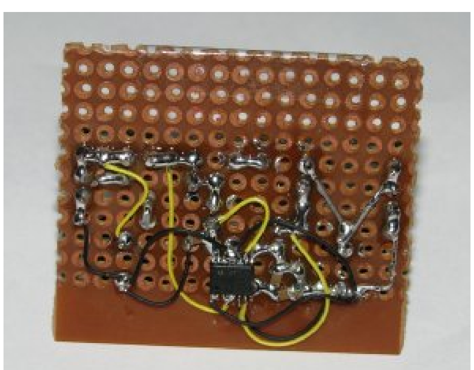


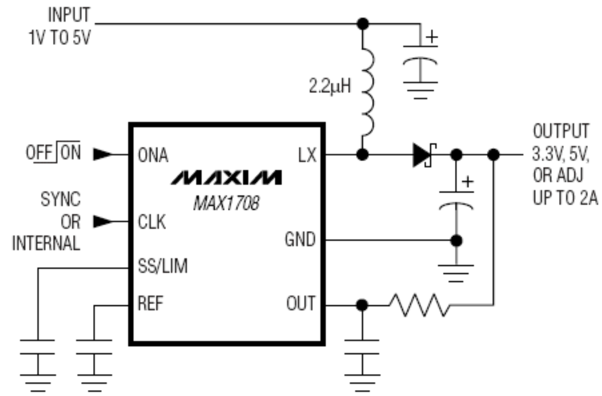


Front (tested with current up to 0.05A. Perheps the inductor used is not correct.)

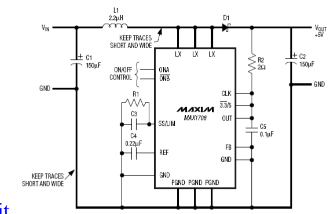


QSOP IC mounted at the back of PCB.





[MAX1708 datasheet]

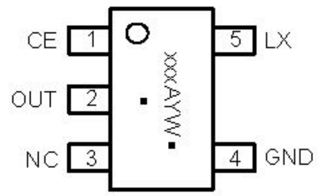


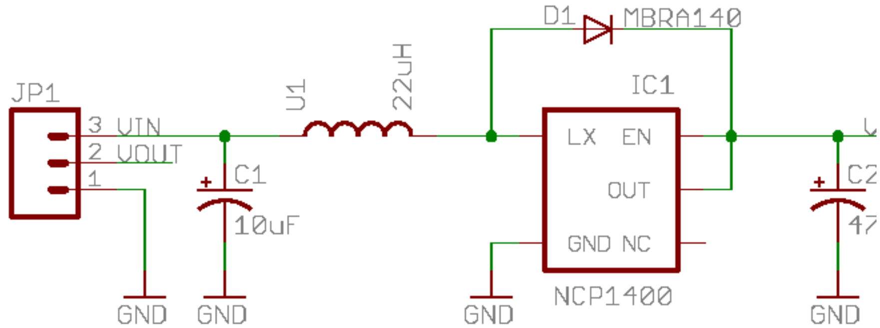
[Click for MAX1708 circuit]

NCP1400a (0.1A)

DC to DC step up voltage regulator.
Low input voltage from 0.8Vdc
to output voltage 1.9-5.5Vdc
Suitable for battery powered circuit.

Package: SOT23-5

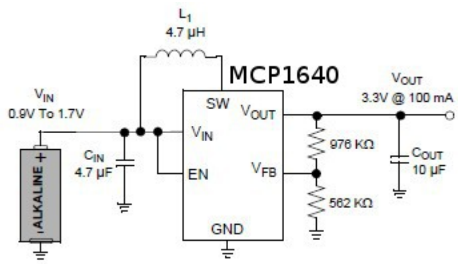




Not tested.

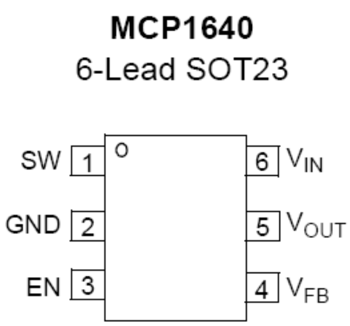
[datasheet.pdf]

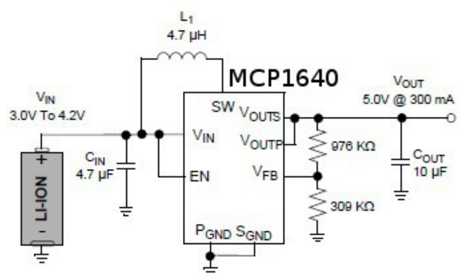
MCP1640 (0.8A)
DC to DC step up voltage regulator.
Low input voltage from 0.35Vdc
to output voltage 2.0-5.5Vdc
Suitable for battery powered circuit.



Package: SOT23-6, DFN

Output 3.3V from a 1.2V alkaline battery using M



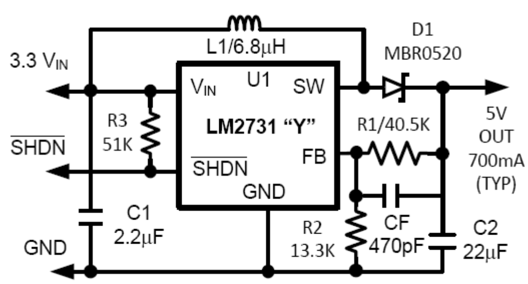


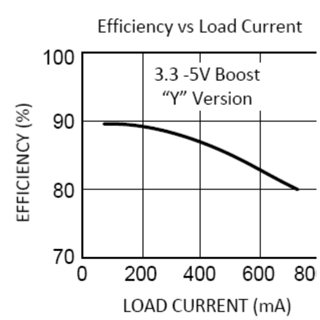
Output 5.0V from a 3.2V LI-ION battery using MC

[MCP1640.pdf]

Not tested.

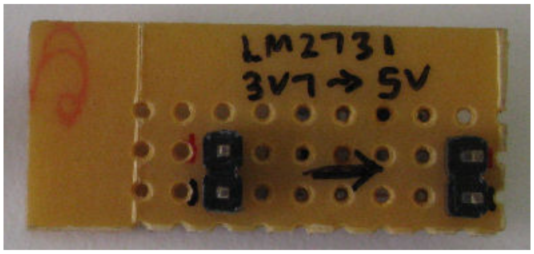
LM2731 (1.8A)
DC to DC step up voltage regulator.
Low input voltage from 2.7-14Vdc
to output voltage up to 20Vdc
Suitable for battery powered circuit.
Li-Ion, Li-Po
NOTE!!! (!SHDN pin does not shutdown the output. When shutdown pin is activated, Vout=Vin-0.2V. Vout will be close to Vin instead of pumping up to a higher voltage when shutdown pin is pull to low.)

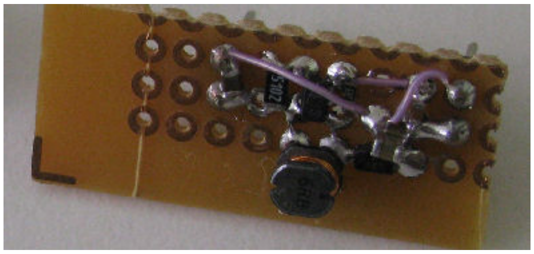


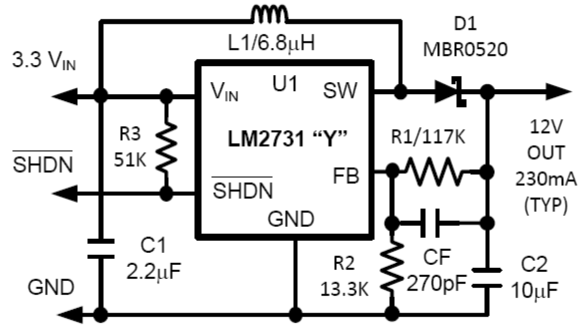


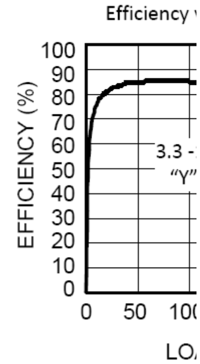
Package: SOT23-5

5V output version

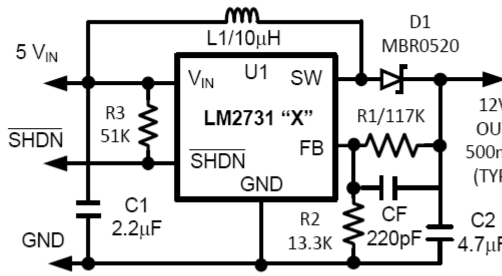


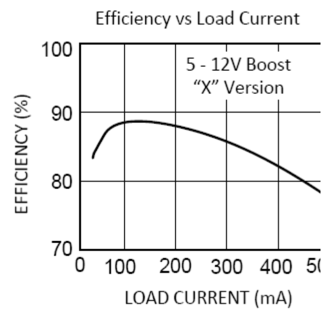




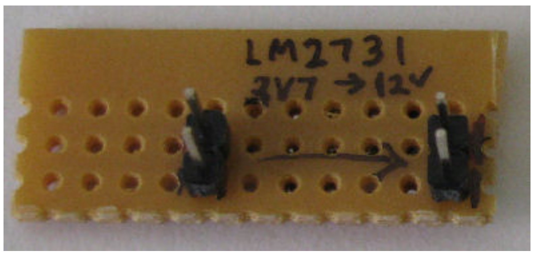


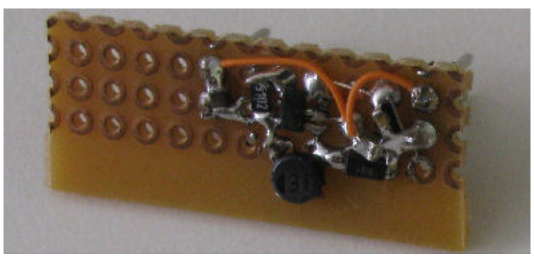
This board uses inductor from BOURNS SDR0403-6R8ML (RMS Current (Irms): 1.41A, Saturation Current (Isat): 2.1A)

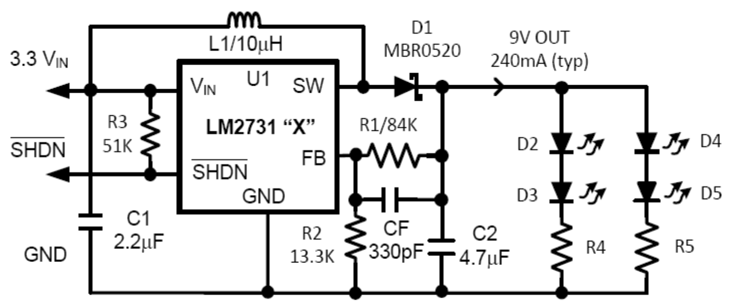


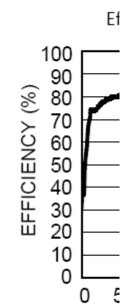


12V output version







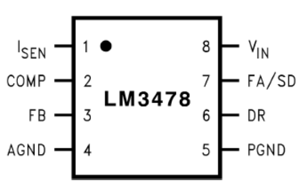


[LM2731.pdf](LM2731.pdf)

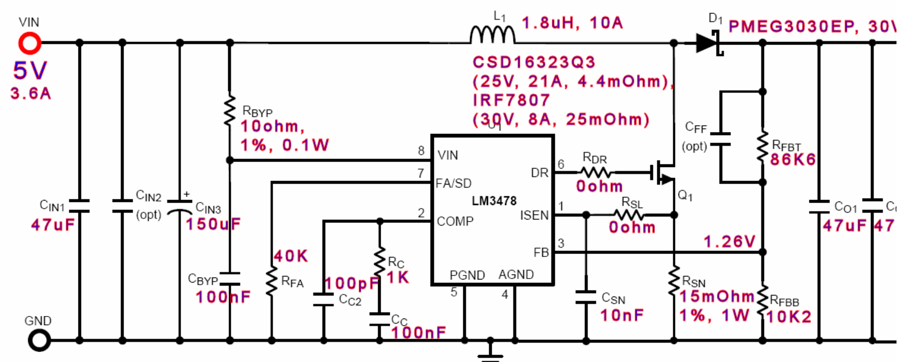
Note: The size of the inductor plays an important part in determine the load's max current.(applies to all s

LM3478
DC to DC step up voltage regulator.
Low input voltage from 2.97Vdc
to output voltage up to 40Vdc

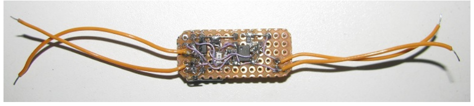
Package: SOIC-8, VSSOP-8

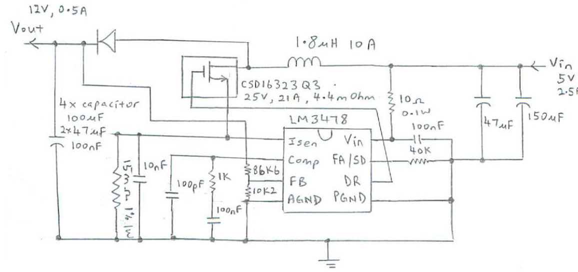


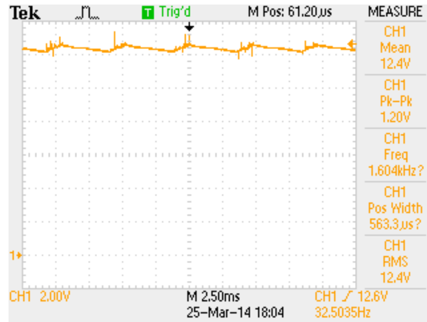
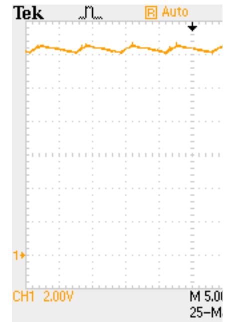
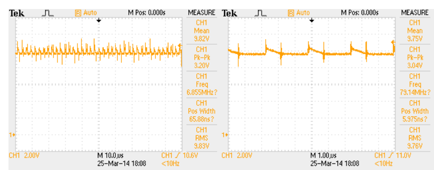
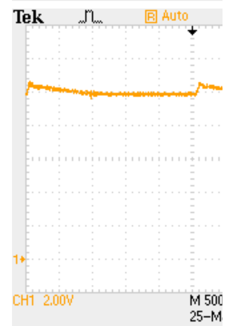
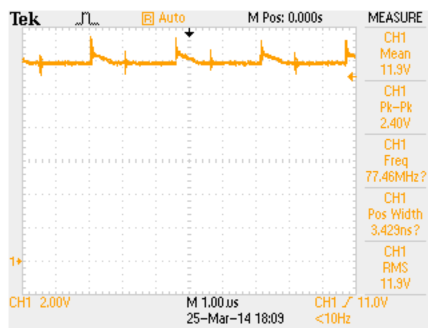
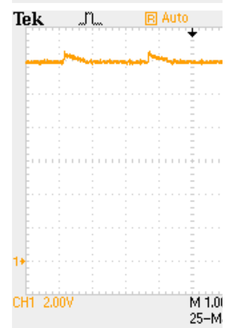
8-Lead SOIC-8
8-Lead VSSOP-8



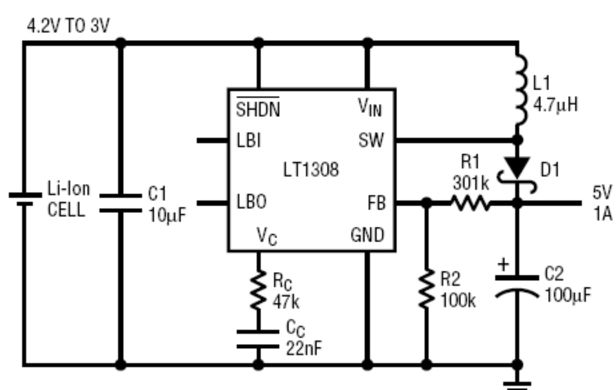
LM3478 datasheet
LM3478 5V-12V application notes



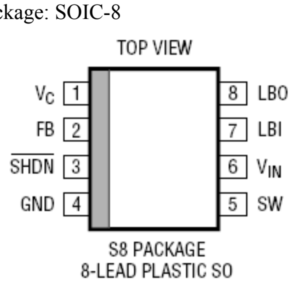


Load used (Ohm)	Vout with 100uF, 47uF	Vout with 100uF, 47uF, 4
1kohm Input = 5V, ??A Output = 12.4V, 12mA		
12ohm Input = 5V, 2A Output = 10.7V, 0.9A		
24ohm Input = 5V, 1.5A Output = 12.0V, 0.5A		

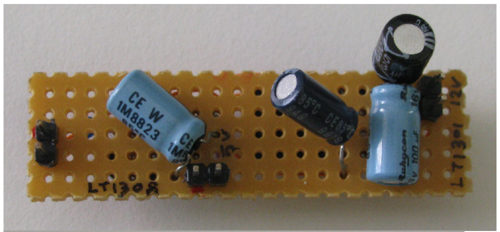
LT1308 (1A)
DC to DC step up voltage regulator.
Low input voltage from 1Vdc
to output voltage up to 3.3V 0.3A, 5.0Vdc 1A)
Suitable for battery powered circuit.
Li-Ion, Li-Po, NiCd

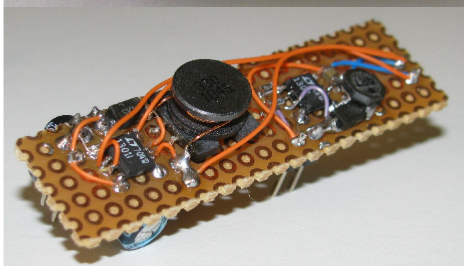


Package: SOIC-8



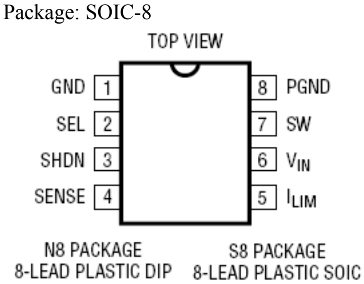
[LT1308.pdf](LT1308.pdf)

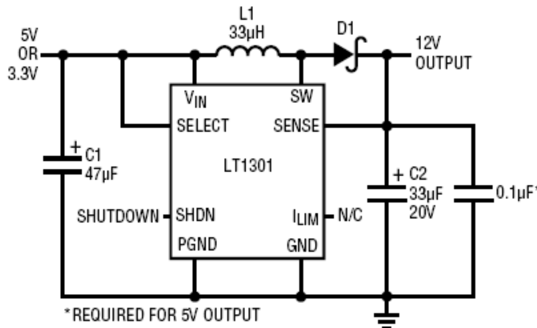




LT1301 (0.12A)
DC to DC step up voltage regulator.
Low input voltage from 1.8Vdc
to output voltage 5V or 12Vdc 120mA
Suitable for battery powered circuit.
Li-Ion, Li-Po

Package: SOIC-8

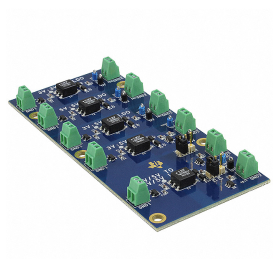




[LT1301.pdf]

SN6501 5V (0.35A), 3V (0.15A)
Switching driver for tranformer isolated power supply.

Package: SOT23-5

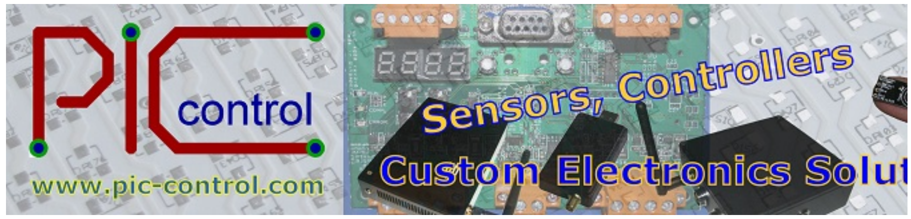


[SN6501.pdf]

[Transformer 760390015.pdf]

Simple DC-DC step up voltage IC
MAX662A 4.5-5.5V to 12V (30mA), no need inductor
MAX734 4.75V - 12V to 12V (120mA)
MAX761 2-16.5V to 12V (150mA)
MAX732 4V - 9.3V to 12V (200mA)
MAX762 2-16.5V to 15V/Adj (150mA)

Ultra Low Drop Regulator MIC5219 (good for Li-Po battery which has a very low voltage)



Diode selection references

Schottky diode (1A)

1N5817, 1N5818, 1N5819, MBR120P, MBR130P, MBR140P, MBR150, MBR160, SR102, SR103, SR1
11DQ04, 11DQ05, 11DQ06

(smd alternative to 1N5819) MBRS140T3G, SS12, SS13, SS14, SK12, SK13, SK14

Schottky diode (3A)

1N5820, 1N5821, 1N5822, MBR320, MBR330, MBR340, MBR350, MBR360, SR302, SR303, SR3(
31DQ04, 31DQ05, 31DQ06

(smd alternative to 1N5820, 1N5821, 1N5822) MBRS320T3, MBRS330T3, MBRS340T3, SS32, SS33, S

Schottky diode (4A-6A)

1N5823, 1N5824, 1N5825, 50WQ03, 50WQ04, 50WQ05, 50WR06, 50SQ060, MBR340

Diode references from Diotec

- diotec diode cross reference list.pdf
- diotec diode case reference.pdf
- diotec diode smd selection.pdf
- diotec transistors-diodes zener selection.pdf
- diotec diode bridges selection.pdf
- diotec smdbridges.pdf
- diotec diode axial.pdf
- diotec hv-diac.pdf
- diotec arrays-special.pdf

Resistor selection references

Introducing the types of resistors

W series- Vitreous enamelled wirewound resistors offering high power, high stability and reliability. Suit

WH series- Aluminium clad resistors for applications where high power dissipation in a small space is rec

MFR series- High stability metal film resistors offering higher performance than carbon film with ve
reliablility.

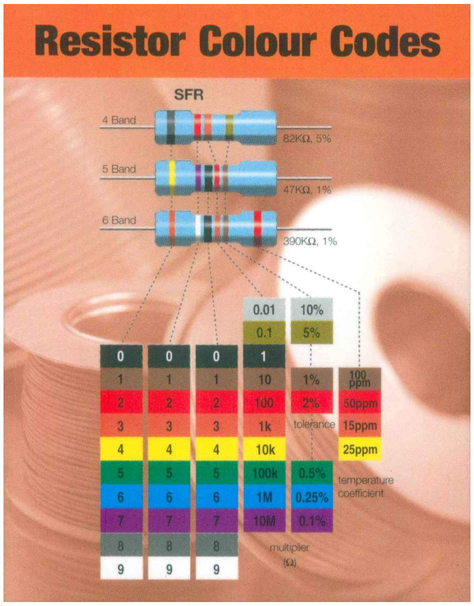
RC series- Very high stability metal film resistors offering very high reliability and tight tolerances.

WCR series- Surface mount resistors suitable for automatic placement. Features include nickel barriers
reliability.

The DC-DC converter design for the adjustable IC version, you may need the following resistor standa
for references. Long time ago, when technology is not so advance, resistor manufacturing is not unab
value, as in today. Due to its large variation in tolerance, the resolution of the range of standard resistor v
series having tolerance of 50%, which have only resistors in decade of 100, 220, 470. There is not much
between 100Ω and 101Ω, having a tolerance of 50%. With such high tolerance, there is hardly any c
101Ω. They should both belongs to the same class of 100Ω

The standard EIA decade resistor value is group into different series. Each is grouped according to their t
tolerance, the higher the resistor value resolution will be. The common resistor value range would be the
(tolerance 1%) series.

To find the range of resistor value that is available in the industrial, multiply the normalise standard foun
1000



Resistor Colour Codes

Images taken Farnell.

for EIA codes for SMD resistors,

please check out this link.

EIA marking code

- Example: E24 series referring to normalise value 1.0

It means that under E24 series, you should be able to find these Ω range 100Ω, 1000Ω, 1kΩ, 10kΩ, 1(Other resistor value under E24 can be determine from the rest of the normalised value in the table below. the series as they should be in resistor package for higher wattage

Standard EIA Decade Resistor Values

E24 (preferred standard resistor values with 5% tolerance) 

1.0	1.1	1.2	1.3	1.5	1.6	1.8	2.0	2.2	2.
3.3	3.6	3.9	4.3	4.7	5.1	5.6	6.2	6.8	7.

E96 (preferred standard resistor values with 1% tolerance) 

1.00	1.02	1.05	1.07	1.10	1.13	1.15	1.18	1.21	1.2
1.33	1.37	1.40	1.43	1.47	1.50	1.54	1.58	1.62	1.6
1.78	1.82	1.87	1.91	1.96	2.00	2.05	2.10	2.15	2.2
2.37	2.43	2.49	2.55	2.61	2.67	2.74	2.80	2.87	2.9
3.16	3.24	3.32	3.40	3.48	3.57	3.65	3.74	3.83	3.9
4.22	4.32	4.42	4.53	4.64	4.75	4.87	4.99	5.11	5.2
5.62	5.76	5.90	6.04	6.19	6.34	6.49	6.65	6.81	6.9
7.50	7.68	7.87	8.06	8.25	8.45	8.66	8.87	9.09	9.3

Tolerance Codes

B=0.1%, C=0.25%, D=0.5%, F=1%, G=2%, J=5%, K=10%, M=20%

website references:
- http://sound.westhost.com/miscc.htm
- http://www.logwell.com/tech/components/resistor_values.html

Most common resistance stock available:
0, 1, 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 75, 82, 100, 120, 150, 180, 200 ,220 ,270, 330, 390, 470, 1.2k, 1.3k, 1.5k, 1.8k, 2k, 2.2k, 2.7k, 3.3k, 3.9k, 4.7k, 5.6k, 6.8k, 7.5k, 8.2k, 10k, 11k, 12k, 13k, 15k

Second common resistance stock available:
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 11, 20, 49.9, 51, 62, 110, 392, 430, 475, 499, 510, 620, 681, 910, 1.02k, 1.24k, 1.33k, 1.62k, 1.82k, 2.21k, 2.4k, 2.49k, 2.74k, : 3.92k, 4.02k, 4.22k, 4.3k, 4.75k, 4.87k, 4.99k, 5.1k, 5.11k, 5.62k, 5.76k, 5.9k, 6.04k, 6.19k, 6.2k, 6.34l 8.06k, 8.25k, 9.1k, 9.53k, 10.2k

Commercial Stock Availiability Statistics from element14 24 Oct 2013, for resistor value >40 types ava

1Ω	10Ω	12Ω	15Ω	18Ω	22Ω	27Ω	33Ω	39Ω	47
46	81	50	66	44	62	49	59	51	6
75Ω	82Ω	100Ω	120Ω	150Ω	180Ω	200Ω	220Ω	270Ω	33
41	54	100	61	79	59	48	67	60	7
560Ω	680Ω	750Ω	820Ω	1KΩ	1K1Ω	1K2Ω	1K3Ω	1K5Ω	1K
56	62	48	64	132	48	67	43	89	6
2K4	2K7	3K	3K3	3K9	4K7	5K1	5K6	6K2	6K
45	64	39	76	63	87	41	67	39	8
10KΩ	11KΩ	12KΩ	13KΩ	15KΩ	18KΩ	20KΩ	22KΩ	24KΩ	27K
132	52	70	45	88	63	63	75	40	6
47KΩ	51KΩ	56KΩ	62KΩ	68KΩ	75KΩ	82KΩ	100KΩ	110KΩ	120
79	39	61	39	63	48	57	122	41	4
180KΩ	200KΩ	220KΩ	270KΩ	330KΩ	390KΩ	470KΩ	560KΩ	680KΩ	820
46	49	57	46	58	46	55	46	51	4

Table for resistor in parallel

This resistor table is interesting. While dealing with circuits prototype, I often need to use resistor value keep sufficient stock for all resistor range is a bit too much to manage. A larger and better storage sys difficult to manage the wide range of resistor. This brings me the idea of forming the required resistance resistor connecting in parallel. This means that I can keep fewer resistance range and easily stock larger q

On the following table, the 1st row and column represents the common resistor value that I normally ke present the various possible resistance I can obtain by having the resistance in parallel from the resp

computation is done in the microsoft excel sheet. formula: "=($A2*B$1)/($A2+B$1)". Those value hi
useful when designing my adjustable DC-DC circuit when I do not have the stock for the resistor that is n

0Ω	10Ω	47Ω	100Ω	120Ω	330Ω	470Ω	560Ω	1kΩ	3k3Ω	4k7Ω	5k6Ω
10Ω	**5**										
47Ω	**8**	**24**									
100Ω	**9**	**32**	**50**								
120Ω	**9**	**34**	**55**	**60**							
330Ω	10	**41**	**77**	**88**	**165**						
470Ω	10	43	**83**	**96**	**194**	**235**					
560Ω	10	43	**85**	99	**208**	**256**	**280**				
1kΩ	10	45	91	**107**	**248**	**320**	**359**	**500**			
3k3Ω	10	46	97	116	**300**	**411**	479	**767**	**1k65**		
4k7Ω	10	47	98	117	**308**	**427**	**500**	**825**	**1k94**	**2k35**	
5k6Ω	10	47	98	117	**312**	**434**	**509**	**848**	**2k08**	**2k56**	**2k80**
10kΩ	10	47	99	119	**319**	**449**	**530**	**909**	**2k48**	**3k20**	**3k59**
100kΩ	10	47	100	120	329	468	557	**990**	**3k19**	**4k49**	**5k30**
1MΩ	10	47	100	120	330	470	560	1k00	3k29	**4k68**	**5k57**

Common Size of Resistor (depending in its wattage)
(This is only a guideline. Always check with the datasheet for the correct wattage.)
(Resistor guide reference website)

Wattage	**SMD (length)**	**Axial resistor size (length)**
1/16W	0603 (1.55mm)	
1/8W	0805 (2mm)	Ø1.8 x 3mm, lead Ø0.45
1/4W	1206 (3.2mm)	Ø2.5 x 6.5mm, lead Ø0.6
1/2W	1210 (3.2mm)	Ø3.2 x 8.5mm, lead Ø0.6
1W	2512 (6.35mm)	Ø5 x 11mm, lead Ø0.6
2W	2512 (6.35mm)	
3W	2512 (6.35mm)	

Capacitor selection references

Typical aluminum electrolytic capacitor size
- Capacitor Vishay datasheet
- Capacitor selection (Panasonic)
- Capacitor selection(Rubycon)

Type of capacitors, advantages and disadvantages explain.

Standard Capacitor Size

Panasonic/Vishay
(Rubycon) -> capcitor dia to lead pitch relationship (dia, lead dia, pitch) (5, 0.5, 2), (6.3, 0.5, 2.5), (8, (
0.6, 5.0), (16, 0.8, 7.5), (18, 0.8, 7.5) -< confirm standard same as Panasonic/Vishay as well.

Cr	6.3V	10V	16V	25V	35V	50V	6
0.1uF						5x11	5
0.22uF						5x11	5
0.33uF						5x11	5
0.47uF						5x11	5
1uF						5x11	5
2.2uF						5x11	5
3.3uF						5x11	5
4.7uF						5x11	5
10uF			5x11			5x11	5
22uF			5x11			5x11	5
33uF			5x11	5x11	5x11	5x11 (6.3x11)	6
47uF			5x11	5x11	5x11 (6.3x11)	6.3x11	6
100uF		5x11	5x11 (6.3x11)	6.3x11	6.3x11 (8x11.5)	8x11.5	1

220uF	5x11	5x11	6.3x11 (8x11.5)	8x11.5	8x11.5 (10x12.5)	10x12.5 (10x16)
330uF	6.3x11	6.3x11	8x11.5	8x11.5 (10x12.5)	10x12.5 (10x16)	10x16 (10x20)
470uF	6.3x11	6.3x11	8x11.5 (10x12.5)	10x12.5 (10x16)	10x16 (10x20)	10x20 (12.5x20)
1000uF	8x11.5	10x12 (10x12.5)	10x16 (10x20)	10x20 (12.5x20)	13x20 (12.5x25)	13x25 (16x25)
2200uF	10x16 (12.5x20)	10x20 (12.5x20)	13x20 (12.5x25)	13x25 (16x25)	16x25 (16x31.5)	16x31.5 (18x35.5)
3300uF	10x20 (12.5x20)	13x20 (12.5x25)	13x25 (16x25)	16x25 (16x31.5)	16x31.5 (18x35.5)	18x35.5
4700uF	13x20 (16x25)	13x25 (16x25)	16x25 (16x31.5)	16x31.5 (18x35.5)	18x35.5	
6800uF	13x25 (16x25)	16x25 (16x31.5)	16x31.5 (18x35.5)	18x35.5		
10000uF	16x25 (16x31.5)	16x35.5 (18x35.5)	18x35.5			
22000uF	18x40 (18x35.5)					

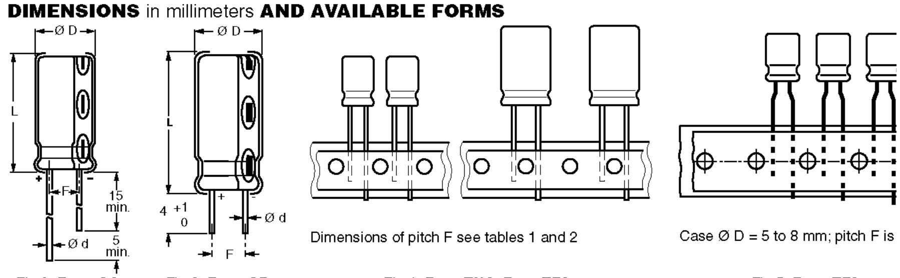
size dia x L in mm

hover to get the case code pin size, pitch

SELECTION CHART FOR C_R, U_R AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V) 6.3	10	16	25	35	50	63	10
0.1	-	-	-	-	-	-	5 x 11	
0.22	-	-	-	-	-	-	5 x 11	
0.33	-	-	-	-	-	-	5 x 11	
0.47	-	-	-	-	-	-	5 x 11	5 x
1.0	-	-	-	-	-	-	5 x 11	5 x
2.2	-	-	-	-	-	-	5 x 11	5 x
3.3	-	-	-	-	-	-	5 x 11	5 x
4.7	-	-	-	-	-	-	5 x 11	5 x
10	-	-	-	-	-	-	5 x 11	6.3 x
22	-	-	-	-	-	5 x 11	5 x 11	6.3 x
33	-	-	-	-	-	5 x 11	6.3 x 11	8 x 1
47	-	-	-	-	5 x 11	6.3 x 11	6.3 x 11	10 x
100	-	5 x 11	5 x 11	6.3 x 11	6.3 x 11	8 x 11.5	10 x 12	10 x
220	5 x 11	5 x 11	6.3 x 11	8 x 11.5	8 x 11.5	10 x 12	10 x 16	13 x
330	6.3 x 11	6.3 x 11	8 x 11.5	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x
470	6.3 x 11	6.3 x 11	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x 20	16 x
1000	8 x 11.5	10 x 12	10 x 16	10 x 20	13 x 20	13 x 25	16 x 25	18 x
2200	10 x 16	10 x 20	13 x 20	13 x 25	16 x 25	16 x 31	18 x 35	
3300	10 x 20	13 x 20	13 x 25	16 x 25	16 x 35	18 x 35	-	
4700	13 x 20	13 x 25	16 x 25	16 x 31	18 x 35	-	-	
6800	13 x 25	16 x 25	16 x 31	18 x 35	-	-	-	
10 000	16 x 25	16 x 35	18 x 35	-	-	-	-	
22 000	18 x 40	-	-	-	-	-	-	

DIMENSIONS in millimeters **AND AVAILABLE FORMS**



Dimensions of pitch F see tables 1 and 2

Case Ø D = 5 to 8 mm; pitch F is

Fig.2 **Form CA**

Fig.3 **Form CB:** Cut leads

Fig.4 **Form TNA, Form TFA:** Taped in box (ammopack), straight leads

Fig.5 **Form TFA:** Taped in box (ammopack), formed

Table 1

DIMENSIONS in millimeters, **MASS AND PACKAGING QUANTITIES**

NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø $D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES FORM CA	FORM CB	FORM TFA, T
5 x 11	11	0.5	5.5	12.5	2.0 ± 0.5	≈ 0.4	5000	-	2000
6.3 x 11	12	0.5	6.8	12.5	2.5 ± 0.5	≈ 0.6	5000	-	2000
8 x 11.5	13	0.6	8.5	12.5	3.5 ± 0.5	≈ 1.1	5000	-	1000
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	3000	1000	500
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	2500	1000	500
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	2000	800	500
13 x 20	17	0.6	13.5	22.0	5.0 ± 0.5	≈ 4.0	1500	400	300
13 x 25	18	0.6	13.5	27.0	5.0 ± 0.5	≈ 5.0	1000	400	300
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	750	200	200
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	600	200	200
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.0	500	200	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	400	150	-
18 x 40	23	0.8	18.5	42.0	7.5 ± 0.5	≈ 16.0	400	150	-

Standard size:

Case Size	Case code
5x11	**11**
6.3x11	12
8x11.5	**13**
10x12	14
10x16	**15**
10x20	16
13x20	**17**
13x25	18
16x25	**19**
16x31	20
16x35	21
18x35	22
18x40	23

Other Step up DC-DC conversion

EMCO HIGH VOLTAGE CORPORATION

Ultra-Miniature High Voltage Power Supplies
Q Series
Q01-5 (5Vdc to 100Vdc)

email: mail@siongboon.com
website: http://www.siongboon.com

Keyword: Buck Regulator, voltage regulator, switching mode power supply, High efficiency, voltage supply, dc-dc converter, LM2576 LM2575 IC, regulated 5Vdc output, Shottky diode, 100uH, 330uH inductor, Low cost, 1A 3A.